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EXPERIMENTAL EPIPHYSEAL TRANSPLANTATION

Part II

Histological observations

By

HENRIK V A HEIKEL

INTRODUCTION AND PROBLEM

In a previous paper I described radiological observations on survival and growth of the autotransplantated proximal end of the fibula to the site of the removed radius and to the thigh of young rabbits It appeared that *the longitudinal growth of the graft in the respective sites amounted to 2 3 and 1/2 of the normal growth of the fibula*

The object of the present histological investigation has been to create a basis for estimating the prospects of successful epiphyseal transplantation and the reasons for failure of such a transplantation by studying which parts of the transplant survive how regeneration takes place and when and how longitudinal growth is resumed

HISTORY

At *reimplantation* of epiphyseal cartilage *Enderlen* observed an increase in volume of the matrix in the centre of the cartilage during the first few days This region degenerated while in the surviving peripheral cartilaginous regions there was abundant cell proliferation followed by continued enchondral new formation of bone *Obata* and *Heller* (1914) similarly observed primary necrosis of the centre of the cartilage followed by almost complete regeneration with hardly any disturbance of growth *Haas* (1915 1916) on the other hand, did not notice any changes in the cartilage during the first two to three weeks after the operation but thereafter at the border between the distal and middle thirds of the epiphyseal cartilage there appeared a zone of lightly staining cells necrosis fragmentation and finally a penetration of connective tissue from the periphery resulting in arrest of growth *Brück* observed necrotic cartilage remnants in the metaphysis at a distance of 2 to 3 mm from the epiphyseal line and believed that these marked the site of the

that the plate could seemingly regenerate completely in all cases but that *growth remained undisturbed only if the reserve zone had been left intact*

METHOD AND MATERIAL

On 34 rabbits 32 autotransplantations of the proximal part of the fibula to the site of the radius and an equal number to the thigh were carried out To investigate the dependence of the result of the transplantation on the stage of development of the epiphyseal cartilage estimated on the basis of the degree of ossification of the epiphyseal nucleus transplantation was in some cases carried out at the age of 10 days when the epiphyseal nucleus is not radiologically demonstrable (9 transplantations to the site of the radius and 14 to the thigh) in some cases at the age of 15 days when the epiphyseal nucleus is sometimes radiologically demonstrable (10 to the site of the radius and 12 to the thigh) and in some cases at the age of 21 days when ossification of the nucleus had set in in all cases (13 transplantations to the site of the radius and 6 to the thigh) The animals were killed 2 to 40 days after the transplantation the extremity in question was examined radiographically fixed in formalin decalcified sectioned and stained with hematoxylin

RESULTS

No certain difference between the different experimental groups ould be established The difference between the results of transplanta ion to the site of the radius and to the thigh which was radiographic lly observed (see part I) must therefore be due to circumstances present after the fortieth day

On the second day after the transplantation when radiologically the transplant was unchanged it lay in a wound cavity where there was in places granulation tissue (Fig 1a) *In the central parts of the piphyseal cartilage* or in those which in the graft lay on the side rthest from the ulna and femur respectively the matrix stained ightly *the cells were scattered and many of them were vacuolized and tained lightly* This ill defined area comprised the major part of both he proliferation zone and the reserve zone and in slides from the oungest animals part of the region of the future epiphyseal nu leus In the metaphysis and the diaphysis no living marrow cells ere visible but the spaces between the primary trabeculae were filled

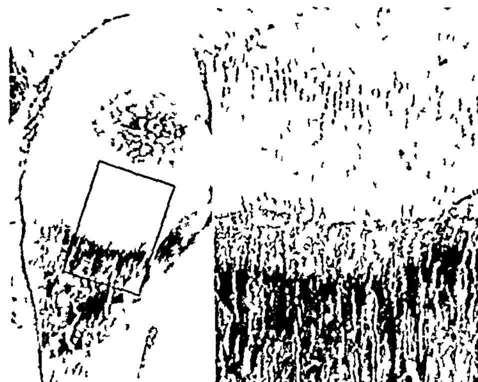


Fig. 1

Exp. 141. Proximal end of the fibula transplanted to the thigh at the age of 15 days; period of observation 2 days. (b = enlarged detail of a)

a. The central parts of the epiphyseal cartilage are lightly stained. Next to this part there is a light arcuate zone in the metaphysis and farther a dark and another light zone.

b. The nuclei within the lightly stained area are shrunken and sparse. Some distance from the metaphyseal border in the metaphysis "packed" detritus may be observed.

with detritus. The latter was divided into *three zones* (Figs. 1 and 2): nearest the borderline between the epiphyseal cartilage and the metaphyseal bone (hereinafter called "the metaphyseal border"), close to the necrotic cartilage region, there was a narrow arcuate zone within which the cell remnants were sparce. There followed a wider dark zone the periphery of which extended to the metaphyseal border and within which the detrital mass was tightly packed, and finally a third diffuse zone with more scattered cell remnants.

On the third to fourth day, when there were still no radiologically demonstrable changes, a slight accumulation of neutrophil granul



Fig 2

Exp 148 Proximal end of the fibula transplanted to the site of the radius at the age of 15 days period of observation 3 days (b — enlarged detail of a)

a Only the peripheral regions of the epiphyseal cartilage have stained well The zonation in the metaphysis i clear

b The metaphyseal trabeculae lack an teoblast lining and the interspaces are fille l with detritus Below to the right penetration of histiocytes

ytes around the transplant was seen and around its diaphyseal end ranulation tissue rich in cells from which streaks of histiocytes enetrated through the marrow cavity in the direction of the epiphyseal late A similar penetration through gaps in the cortical layer was een here and there No other living cells were seen in either the meta hysis or the diaphysis The zonal division was sharper in some slides while in others it was more diffuse than on the second day

The signs of *necrosis of the epiphyseal cartilage* were more distinct han on the second day and the limits of the lightly staining area were harper (Fig 2b) In some slides this area comprised *almost the entire roliferation one* but as a rule *only a small central portion of the*



Fig 4

Exp 147 Proximal end of the fibula transplanted to the thigh at the age of 11 days period of observation 4 days (highly magnified) The bone trabeculae of the metaphysis lack an osteoblast lining the interspaces being filled with detritus The arrows indicate isolated macrophages filled with cell remnants

within which there were neither osteoblasts nor living erythrocytes though other parts of the metaphysis and the epiphyseal nucleus were well nourished In the metaphysis and the diaphysis isolated osteoclasts were also observed and in some slides remnants of detritus and *macrophages filled with phagocytized material* (Fig 4)

The necrotic portion of the epiphyseal cartilage was sharply defined and seemed *laterally compressed particularly in the columnar zone in which the columns were arched with the convexity towards the necrotic area* but also within the reserve zone (Figs 3a 5) The mushroom like necrotic area penetrated 1 2 to 1 mm into the metaphysis Within it columnar cells with slightly stained yellowish shrunken nuclei could be observed

Along the metaphyseal border there was vigorous ossification except at the transition zone to the necrotic cartilaginous region The newly formed primary bony trabeculae were irregular and in places contained considerable amounts of uncalcified matrix



a b

Fig. 3.

Fig. 15. Proximal end of the fibula transplanted to the thigh at the age of 21 days. [illegible] day of observation [illegible] (b) — enlarged detail of a.

a. The necrosed cartilage which comprises 3/4 of the width of the epiphysis has been replaced from the [illegible] while it has been left behind in the metaphysis.

b. The arch shape of the regenerating columns illustrate how they partly cut off the necrotic cartilage which still extends to the epiphyseal nucleus. On the metaphyseal side of the necrotic cartilage the bony trabecular lack an [illegible] lining and in the interspaces there is detritus.

On the ninth day, when no bony contact could yet be demonstrated while the growth in length of the graft could be radiographically shown to be 1.2 to 3 mm, the epiphyseal plate seemed almost normal in some slides though the *reserve zone appeared to be thinner than normal in all*. In other slides a more or less centrally situated streak of connective tissue was seen reaching from the epiphyseal nucleus into the epiphyseal plate or through it to the metaphysis. Continuous from this streak there was *a triangular necrotic cartilaginous area* in the metaphysis and *the distance from the base of this triangle to the metaphyseal border* was in most cases *exactly the same as the length*



a b

Fig 6

Exp 155 Proximal end of the fibula transplanted to the thigh at the age of 15 days Period of observation 9 days (b = enlarged detail of a)

a Half of the epiphyseal plate has been left behind stepwise in the metaphysis

b Above left a vascular connective tissue streak is seen growing through the epiphyseal plate and in its prolongation a triangular necrotic cartilage is seen sunk into the metaphysis The columns of the regenerating epiphyseal cartilage extend from a common point in the reserve zone

tudinal growth of the graft as measured on radiograms In some cases the base of the cartilaginous triangle reached to the periphery of the graft (Fig 6) and in these cases another triangular area with irregular newly formed primary bony trabeculae was observed between the necrotic cartilage the metaphyseal border and the periphery of the graft (Fig 6b) In some slides the epiphyseal plate was stepped in shape the step protruding farthest into the metaphysis being on the same side as the greater part of the eccentrically situated necrotic cartilage triangle (Fig 6a) The osteoblasts of the metaphysis looked normal





Fig Fig 8

Fig

Fig. 149. Le simal en l f th fibula tran pl nte l t th thigh at the age f 11 f ss t t f f f er ati n 14 fav. Th epiphy eal plate l s ks n rmal with th excep t n f a n r w vascular tr ak gr wing from th epiphy eal nu l u l wn int th epiphy eal plat Th bar hyst f th gr ft has fu l with th f mur

Fig 8

Fig 151 l s m l n l f th fibula tran plante l t the thigh at the ag f l a f s l s t f l t n 13 f Already partly ff t t ake on s th epiphy l nu l u with t m t ph t n other t c f th treak the epiphy eal plate l k n m l flow n th bar l t f the graft an l th f mur th re l a call s wh h h ls d n l ntrally ret r with ut r gular c lumn

and in m st slides vered all trabecul e while in other slides l th calcified cartilage and hemopoietic elements were absent from a narrow ne at the base of the cartilaginous triangle In some slides a comparatively large number of osteoclasts were seen

From the thirteenth day on when some transplants had fused with

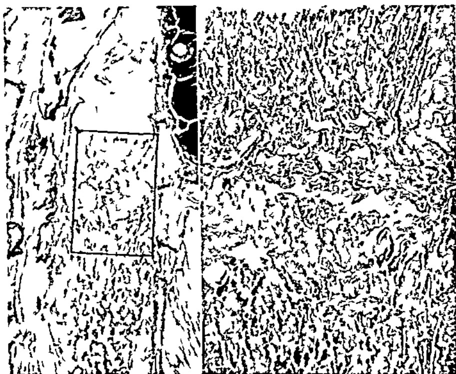


Fig 9

Exp 131 Proximal end of the fibula transplanted to the site of the radius at the age of 14 days Period of observation 14 days (b = enlarged detail of a)

a The epiphyseal plate looks normal except that in the part of the reserve zone furthest from the ulna the nuclei have stained lightly The diaphysis has fused with the ulna

b There are islets of necrotic cartilage in the metaphysis The osteoblast lining of the bony trabeculae extends to these islets and near them there are osteoclasts

the ulna or the femur the histological pictures varied more In some cases the epiphyseal plate looked almost normal and there was a normal relation between the zones although their continuity was interrupted by a longitudinal vascular connective tissue streak between the epiphyseal nucleus and the metaphysis (Fig 7) This streak was ossified in some cases (Fig 8) In other slides a lightly staining area could be seen in the otherwise normal epiphyseal plate within the reserve zone which in the transplant lay on the side farthest from the ulna or femur respectively (Fig 9a) In some slides the reserve zone seemed to be extremely thin and in between this zone and the



a b

Fig 10

Exp 96 Proximal end of the fibula transplanted to the thigh at the age of 22 days Period of observation 23 days (b = *enlarged detail* of a)

a. The graft which had grown 6 mm did not fuse with the femur The epiphyseal plate is regular but the reserve zone in particular is thin The structure of the metaphysis is regular 6 mm from the metaphyseal border a transverse streak is seen (see arrow!)

b The transverse streak consists of islets of necrotic cartilage in which the cells are clearly visible The border regions of the islets are calcified near them there are osteoclasts

apparently normal columnar zone connective tissue cells penetrated from the periphery

The primary bony trabeculae of the metaphysis were mostly regular but *up to 23 days after the transplantation islets of necrotic cartilage were still visible* in which lightly staining columnar cells were identified and formed a transverse zone across the metaphysis *at a distance of up to 6 mm from the metaphyseal border* (Figs 9b 10 a b)

In other slides of fibulae transplanted at various ages only insigni



Fig 10

Exp 96 Proximal end of the fibula transplanted to the thigh at the age of 22 days Period of observation 23 days (b = enlarged detail of a)

a The graft which had grown 6 mm did not fuse with the femur The epiphyseal plate is regular but the reserve zone in particular is thin The structure of the metaphysis is regular 6 mm from the metaphyseal border a transverse streak is seen (see arrow!)

b The transverse streak consists of islets of necrotic cartilage in which the cells are clearly visible The border regions of the islets are calcified near them there are osteoclasts

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The necrotic cartilage does not ossify and one result of this is that it is overrun by the newly formed metaphyseal bone *and is left behind in the metaphysis* as was also observed by *Brücke* The mushroom or triangular shape of the cartilaginous area left behind is partly due to the fact that the necrosis primarily comprised a narrower area of the reserve zone than of the columnar zone being partly a result of pressure upon the necrotic cartilage by the regenerating epiphyseal plate from the sides When this cartilage has become cut off from the epiphyseal plate it is gradually split into cartilage islets irregular in shape The same phenomenon has been observed and described in detail by *A Langenskiold* and *W Edgren* as a result of necrosis produced by local irradiation of the epiphyseal plate

The reason why the necrotic cartilage still does not ossify when after the ninth day the osteoblastic lining and the capillaries finally reach it remains obscure *Henrichsen* however recently showed that the enzyme necessary for calcification alkaline phosphatase occurs in the cartilage cell when this undergoes a natural degenerative process and that calcification cannot take place before this process is completed and the cell is dead It is therefore conceivable that the cells in the necrotic cartilage which have not undergone natural degeneration do not contain the amount of alkaline phosphatase necessary for normal calcification How the necrotic cartilage after splitting into small cartilage islets finally disappears is not clearly apparent but the calcification of the borders of the islets and an accumulation of osteoclasts near the islets observable in some slides suggest two different alternatives

CONCLUSIONS

1 Under the given experimental conditions a thin peripheral layer of the columnar zone and a thicker layer of the reserve zone survive autotransplantation The centre of both these zones and all cell elements of the metaphysis undergo necrosis

2 The epiphyseal cartilage regenerates from the surviving parts of the reserve zone whose cell producing capacity is thereby partially exhausted which results in subsequent inhibition of growth Regeneration proceeds towards the centre of the epiphyseal plate cutting off the necrotic cartilage region The marrow cells of the metaphysis probably regenerate from histiocytes penetrating from the surround

ings Regeneration begins after about 3 to 4 days and is completed about 9 to 13 days after the transplantation

3 As soon as regenerating osteoblast linings and capillaries have reached the metaphyseal border before the seventh day at earliest ossification of surviving and regenerating parts of the columnar zone begins and the longitudinal growth of the transplant continues

SUMMARY

In 10 15 and 21 day old rabbits autotransplants of the proximal end of the fibula were made in some cases to the site of the radius which had been dissected extraperiosteally and removed and in some to the thigh and were histologically examined after 2 to 40 days

There was no difference between the results in the different age groups or after transplantation to the site of the radius or to the thigh

In the centre of the epiphyseal cartilage there occurred an extensive necrosis (Figs 1 and 2) which on the fourth to the thirteenth day was replaced through regeneration from surviving parts of the reserve zone (Fig 5) All marrow cells of the metaphysis underwent necrosis as well and in the detritus a characteristic zonation was observed (Figs 1 and 2) the reasons for which are discussed The marrow cells regenerated probably from penetrating histiocytes between the fourth and ninth days As soon as the regenerating osteoblast lining and the capillaries reached the metaphyseal border ossification of the surviving and regenerating parts of the columnar zone began while the necrotic cartilage did not ossify but was left behind in the metaphysis (Figs 3 5 to 10 and 11) The reasons for the non occurrence of ossification are discussed Though in successful cases the epiphyseal zone seemed to regenerate completely this seemed to take place at the expense of the capacity for cell proliferation of the reserve zone which may be held to explain why the total growth capacity of the transplant is less than that of the normal bone

RESUME

Des autotransplantations de l extremite proximale du perone ont été effectuees chez des lapins ages de 10 15 et 21 jours dans certains cas a la place du radius qui a ete disseque extrapériostalement et enleve et dans d autres sur la cuisse et qui ont ete examinees histologiquement apres 2 a 40 jours

Il n'y avait aucune différence entre les résultats chez les différents groupes d'âges ou après transplantation à la place du radius ou sur la cuisse.

Dans le centre du cartilage épiphysaire il s'était produit une nécrose extensive (fig 1–2) qui entre le 4ème et le 13ème jour a été remplacée par la régénération de parties survivantes de la zone en réserve (fig 5). Toutes les cellules de moëlle de la métaphyse ont également subi des nécroses, de même qu'on a observé dans le détritus une division en zones caractéristique (fig 1 et 2) dont les raisons sont discutées. Les cellules de moelle régénèrent probablement par suite de la pénétration d'histiocytes entre le 4ème et le 9ème jour. Aussitôt que la doublure formée par les ostéoblastes régénérés et les capillaires atteint la bordure métaphysaire, l'ossification des parties survivantes et régénérées de la zone colonnaire commence, alors que le cartilage nécrotique ne s'ossifie pas, mais s'affaise dans la métaphyse (fig 3, 9 à 10 et 11). Les raisons de la non apparition de l'ossification sont discutées. Bien que dans les cas heureux la zone épiphysaire paraît complètement régénérée, cela semble se faire aux dépens de la capacité de prolifération des cellules de la zone en réserve, ce qui pourrait expliquer que la capacité totale de croissance de la transplantation est moins forte que dans un os normal.

ZUSAMMENFASSUNG

An 10, 15 und 21 Tagen alten Kaninchen wurden Autotransplantationen des proximalen Endes der Fibula in einigen Fällen an die Stelle des Radius, der extraperiostal präpariert und entfernt worden war, in anderen zum Oberschenkel vorgenommen. Die Transplantate wurden nach 2 bis 40 Tagen histologisch untersucht.

Kein Unterschied zwischen den Ergebnissen der verschiedenen Altersgruppen oder nach Transplantation zum Radius oder Oberschenkel konnte gefunden werden.

Im Zentrum des Epiphysenknorpels entstand eine ausgedehnte Nekrose (Fig. 1 und 2), die am vierten bis dreizehnten Tage durch Regeneration von überlebenden Teilen der Reservezone erstattet wurde (Fig. 5). Alle Markzellen der Metaphyse wurden ebenfalls nekrotisch und im Detritus wurde eine charakteristische zonenartige Anordnung beobachtet (Fig. 1 und 2), deren Ursach besprochen wird. Die Markzellen regenerierten wahrscheinlich von eindringenden Histiozyten zwischen dem vierten und neunten Tage. So bald die reger[illegible]

Osteoblastschichte und die Kapillaren die Metaphysengrenze erreichten begann die Verknöcherung der überlebenden und regenerierenden Teile der Säulenzone, während der nekrotische Knorpel nicht verknöcherte, sondern in der Metaphyse hintergelassen wurde (Fig 3, 5 bis 10 und 11). Die Gründe für das Nichtauftreten von Verknöcherungen werden besprochen. Obwohl die Epiphysenzone in erfolgreichen Fällen vollkommen zu regenerieren schien, geschah dies doch augenscheinlich auf Kosten der Proliferationsfähigkeit der Zellen der Reservezone. Dies kann erklären, weshalb die gesamte Wachstumsfähigkeit des Transplantates geringer ist als die von normalen Knochen.

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ORIGIN OF METAPLASTIC CARTILAGE IN SKIN ARTHROPLASTY

By

KAUKO O KETTUNEN

When the mesenchymal cells become differentiated into different types of connective tissue some of the cells remain at a less differentiated stage Thus connective tissue always contains a host of multipotent connective tissue cells which may undergo metaplastic development into a new type of connective tissue (*Maximow* 1926 1927 *Ham* 1953) Both experimental studies and clinical observations have shown that cartilaginous metaplasia occurs in the connective tissue used as interposition material in skin arthroplasties (*Kettunen* 1958 1959) Connective tissue growing from a freshened articular surface and the connective tissue of the skin graft are subjected to pressure and function of the joint Multipotent connective tissue cells then undergo metaplastic development into cartilage

The origin of the cells undergoing metaplastic development is a very interesting problem It may be assumed that the cells derive from both granulation tissue growing from freshened joint surface and from the connective tissue of the skin graft i e the granulation tissue and the transplants both take an active part in the formation of new metaplastic cartilage It may also be assumed that metaplastic cells derive from granulation tissue and that the connective tissue of the skin graft functions merely as the culture medium for granulation tissue undergoing *metaplasia and as interposition material protecting it against the pres*sure exerted by the joint (*Kettunen* 1958)

The purpose of the present investigation is to study the origin of

1 This work has been aided by an institutional grant from Sigrid Juselius Foundation Helsinki Finland to the Institute of Forensic Medicine University of Helsinki



Fig 1

The preparation 2 week postoperatively Left surface of the acetabulum from which articular cartilage has been removed (A) In the middle granulation tissue (C) that has grown from the bone surface and right degenerating homoplastic skin graft (T) × 80

metaplastic cartilage by using fresh homoplastic skin graft instead of fresh autogenous skin graft as interposition material in skin arthroplasties in the hip joint of cats It is known that a homoplastic graft is always destroyed (*Peer* 1955) If homoplastic tissue is employed as interposition material it is possible to eliminate the multipotent connective tissue cells of the autogenous graft that might participate in the formation of new articular cartilage The results thus obtained have been compared with those of earlier experiments using autogenous interposition material to find out the role of granulation tissue growing from the articular surface and the part played by the connective tissue of a skin graft in the formation of new metaplastic articular cartilage

MATERIAL AND METHODS

A total of ten adult cats was used for the experiments The operation technique was the same as in the previous experiments (*Kettunen*

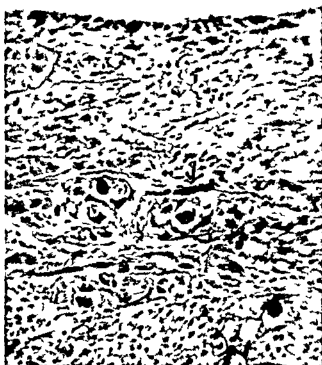


Fig 2

The preparation 6 weeks postoperatively New connective tissue growing from the bone surface has replaced almost completely the degenerating *homoplastic connective tissue* In the middle remains of degenerative collagenous bundles (arrow) At the top articular surface × 160

1958) The hip joint was opened up the cartilage of the acetabulum removed and a skin graft taken from another cat was placed on the freshened joint surface The animals were sacrificed 2 3 4 5 6 7 8 10 12 and 14 weeks after the operation The acetabulum was now detached completely fixed in 10 per cent neutral formalin decalcified in 5 per cent trichloracetic acid and the preparations were stained by the Weigert van Giessen method (*Romeis* 1948)

MACROSCOPIC OBSERVATIONS

During the first month of observation the transplant was visible to the naked eye In some of the cases the graft was destroyed in the weight bearing area of the joint and the articular surface consisted of bare bone It was no longer possible during the second month of obser

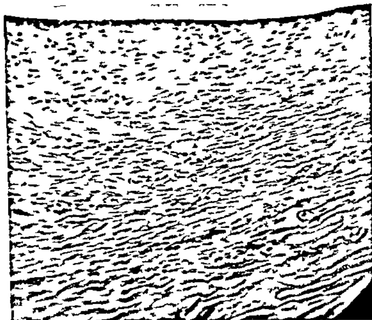


Fig 3

Th preparation 12 weeks postoperatively The ground substance f the connective tissue near t the articular surface has increased and contains slightly differentiated connective tissue cell Deeper d wn there is dense fibrous connective tissue At the t p the articular surface × 100

sition to discern the skin graft macroscopically The articular surface was covered by a layer of connective tissue which was destroyed in a part of the preparations in the weight bearing area There were no signs of cartilaginous metaplasia The situation remained roughly unchanged during the third month Incipient cartilaginous metaplasia was established in a preparation taken 14 weeks postoperatively A part of the connective tissue covering the joint surface in the weight bearing area of the joint resembled fibrous cartilage

MICROSCOPIC OBSERVATIONS

Pronounced signs of degeneration were observed in the epidermis and dermis of the skin graft during the first month of observation New connective tissue grew from the joint surface from which the articular cartilage had been removed This new tissue penetrated here and there into the connective tissue of the degenerating skin graft Foci of

immediately after surgery to articular pressure causing metaplasia If again homoplastic connective tissue is used as interposition material the multipotent connective tissue cells of the granulation tissue must grow through the degenerating transplant to the joint surface in which the metaplasia begins In my opinion this observation i e the weakening and retardation of cartilaginous metaplasia when homoplastic connective tissue is used as interposition material lends support to the view that autogenous connective tissue graft participates actively in the formation of new metaplastic cartilage of the joint

For clinical skin arthroplasties the following important conclusions can be drawn

– granulation tissue deriving from bone marrow and growing from articular surface freshened in connection with skin arthroplasties plays an important role in the formation of new metaplastic articular cartilage *It is consequently necessary in clinical skin arthroplasty to perform the freshening of the articular surface with great care in order to produce the best possible conditions for the formation of vigorous connective tissue capable of metaplasia*

– fresh autogenous skin graft used as interposition material protects granulation tissue capable of metaplasia against articular pressure

– the multipotent connective tissue cells of the autogenous skin graft participate actively in the formation of new joint cartilage

SUMMARY

The origin of metaplastic articular cartilage originating in skin arthroplasties was studied using fresh homoplastic skin transplant as interposition material in arthroplasties in the hip joint of cats The results obtained were compared with authors previous experimental investigations in which fresh autogenous skin graft was used as interposition material in arthroplasties The new connective tissue growing from freshened articular surface was found to be important for the formation of metaplastic joint cartilage The freshening of the articular surface in skin arthroplasties is a precondition for the formation of vigorous granulation tissue capable of a metaplastic process and it must therefore be performed with great care The role of the autogenous skin graft used as interposition material is protection of the connective tissue growing from the surface of the bone against articular pressure and the multipotent connective tissue cells of the skin transplant take an active part in the formation of new articular cartilage

RÉSUMÉ

L'origine du cartilage articulaire métaplastique provenant d'arthroplasties de peau a été étudiée en utilisant une transplantation homoplastique de peau comme matériel d'interposition dans les arthroplasties de l'articulation de la hanche chez les chats. Le résultat obtenu a été comparé aux recherches expérimentales effectuées antérieurement par l'auteur dans lesquelles des greffes autogènes fraîches de peau avaient été utilisées comme matériel d'interposition dans les arthroplasties. On a constaté que le nouveau tissue conjonctif qui s'est formé à partir de la surface articulaire reconstruite était important pour la formation du cartilage articulaire métaplastique. La réfection de la surface articulaire dans les arthroplasties de peau est la première condition à la formation d'un tissu de granulation vigoureux capable de processus métaplastique et doit être effectuée avec beaucoup de soin. Le rôle de la greffe autogène de peau utilisée comme matériel d'interposition est de protéger le tissu conjonctif qui se forme de la surface de l'os contre la pression articulaire et les cellules multipotentes du tissu conjonctif de la greffe épidermique prennent une part active à la formation du nouveau cartilage articulaire.

ZUSAMMENFASSUNG

Die Entstehung von metaplastischem Gelenksknorpel in ursprünglichen Hautarthroplastiken wurde untersucht, indem man frische homoplastische Hauttransplantate als Interpositionsmaterial bei Arthroplastiken des Hüftgelenkes von Katzen benutzte. Die erhaltenen Ergebnisse wurden mit vorhergehenden experimentellen Untersuchungen des Verfassers verglichen, in denen frische autogene Hauttransplantate als Interpositionsmaterial bei Gelenksplastiken verwendet worden waren. Das neue, von angefrischten Gelenksoberflächen wachsende Bindegewebe wurde als wichtig für die Bildung von metaplastischem Gelenksknorpel befunden. Die Anfrischung der Gelenksoberfläche bei Hautarthroplastiken ist eine Vorbedingung für die Bildung eines kräftigen Granulationsgewebes, das zur Metaplasie fähig ist, und sie muss daher mit grosser Vorsicht ausgeführt werden. Die Rolle des autogenen als Interpositionsmaterial verwendeten Hauttransplantates besteht in der Beschützung des von der Knochenoberfläche gegen den Gelenksdruck wachsenden Bindegewebes und die multipotenten Bindegewebszellen des Hauttransplantates nehmen aktiv teil an der Bildung des neuen Gelenksknorpels.

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THE TREATMENT OF FRACTURES OF THE NECK OF THE FEMUR BY COMPRESSION

By

JOHN CHARNLEY, F.R.C.S.

It is probable that immediate prosthetic replacement of the femoral head after subcapital fractures of the neck of the femur in senile patients will be used more commonly in the future in preference to internal fixation. In senile patients there is much in favour of this policy, but we must not abandon attempts to improve internal fixation in the case of patients with an expectation of ten or more years of life. It is unfortunate that surgeons do not appear to have an agreed opinion on the frequency of failure of simple forms of internal fixation such as the Smith-Petersen nail. There is a tendency for surgeons who were using the Smith-Petersen nail before the outbreak of the Second World War to remain faithful to it, though biomechanical studies of this fracture indicate dissatisfaction with the simple Smith-Petersen nail. Because ischaemic necrosis in the femoral head is a matter outside the surgeon's control, some surgeons have adopted a reactionary policy and returned to the simple Smith-Petersen nail with early weight bearing. Past experience has shown, however, that many failures with the simple Smith-Petersen nail occur *in the presence of a viable head*, and it would therefore seem justifiable to employ complicated methods of internal fixation if thereby it were possible to eliminate failure when the femoral head possessed a reasonable blood supply.

Those who attempt to belittle the efforts of the perfectionist in developing methods of internal fixation for subcapital fractures of the neck of the femur often use the argument that, even if union of the fracture is obtained in the presence of ischaemia of the femoral head, the result will still be a failure because collapse of the pressure-bearing surface

of the head will occur in the subsequent two or three years. But ischaemic necrosis of the femoral head is not always a totally disabling complication and it has still to be proved that two years after a prosthetic replacement a hip is more comfortable than a head showing ischaemic collapse. The development of ischaemic collapse of the pressure surface of the head following successful union at the fracture site in younger patients is a condition which can be successfully treated by methods suitable for osteoarthritis of the hip, and after union of the fracture the problem of ischaemic necrosis of the head is less difficult to treat than an un-united fracture of the neck of the femur.

It is obvious that successful results after subcapital fractures of the neck of the femur will never be obtained in 100 % of cases, but it would seem reasonable to suggest that if successful union could be obtained in 80 % to 85 % of patients some mechanical elaboration of the technique would be justifiable because many surgeons believe that for subcapital fractures simple methods of internal fixation are successful in only 60 % to 70 % of patients.

An attempt is made in this paper to evaluate the mechanical efficiency of different methods of internal fixation of intracapsular fractures of the neck of the femur and to advance reasons for the use of a spring-loaded compression screw. Certain technical details in the use of the author's compression screw are emphasised and some new ideas introduced as a result of further experience.

MECHANICS OF FIXATION METHODS

Smith-Petersen Nail. The design of the Smith-Petersen tri-fin nail was dominated by the desire to prevent rotation in the axis of the neck. While successful in this, we now know that the mechanical weakness of this nail lies in its failure to resist external rotation of the distal fragment and varus displacement of the head. The failure to resist a recurrence of the initial deformity is frequently the result of comminution of the posterior surface of the femoral neck which is often more extensive than might be imagined from the X-ray. When a fracture of the femoral neck is reduced by internal rotation of the distal fragment the anterior cortex of the femur is compressed while the posterior cortex is under tension. When the force holding internal rotation is removed the shattered posterior cortex of the femoral neck is unable to act as a compression strut to resist the tendency of the distal fragment to fall again into external rotation (Fig. 1). In the reduced position a

comminuted fracture of the femoral neck is therefore in an unstable position and the whole of the force tending to cause recurrence of the deformity will fall on the Smith Petersen nail If the fracture is not comminuted the reduced position will have inherent stability and in these cases the simple Smith Petersen nail will be adequate to maintain the immobilisation

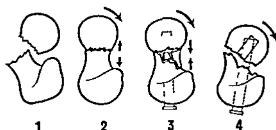


Fig 1

Mechanical weakness of Smith Petersen nail When the fracture is *not* comminuted (1 and 2) the reduced position is stable and the Smith Petersen nail is likely to be successful When the fracture is comminuted on the posterior surface the reduced position (3) is an unstable position and the nail is exposed to forces tending to make it cut out as the head falls back into the position of original deformity (4)

Shaft Fixation To ensure rigidity against forces causing varus deformity we are now familiar with the various forms of blade plate in which shaft fixation was added to Smith Petersen's tri fin nail The addition of shaft fixation to the Smith Petersen nail in the treatment of subcapital fractures makes it difficult to estimate the exact length of nail which will be required The correct length of the nail in subcapital fractures is critical if the maximum hold on the small medial fragment is to be obtained without penetration into the joint A further disadvantage of this type of shaft fixation is that it prevents extrusion of the nail and if collapse of the fracture occurs during healing the point of the nail will penetrate the joint

Sliding Nails Several new patterns of nail which combine shaft fixation with the ability of the nail to extrude are undergoing clinical trials at the present moment notably that described by Pugh (1955) These devices utilise a component of the body weight to generate a compression force at the fracture line and encourage collapse of the fracture without a tendency for the head to shear in a varus direction It will be noted that in these devices the maximum compression force is obtained with a valgus position of the nail

In the Pugh nail resistance to rotation is obtained by a mechanical

device consisting of a peg engaging in a groove in the sliding apparatus (Fig 2). This is a weak point in design because a perceptible clearance must be allowed to guarantee free sliding and this allows slight rotary play at the fracture. It is true this play will only operate when muscle-tone is abolished but a slight rotary play in the apparatus will be magnified on the greater radius at the circumference of the fracture.

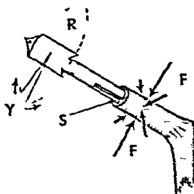


Fig 2

Schematic representation of the Pugh Sliding Nail. A device is incorporated in the sleeve to exert frictional resistance F against free extrusion; this is in effect a distracting force which has to be neutralised by weight bearing or the action of muscle tone. Y indicates the movement expressed as linear at the surface of the femoral head, which results from the slight rotational "play" of the slot, S, on the peg which is integral with the sleeve.

A further technical difficulty in designing a nail to facilitate extrusion is the tendency which all nails possess for spontaneous extrusion. Various devices have been used to stop this tendency in the Smith Petersen nail, such as the Pidcock check or the use of serrations on the flanges of the nail. To offer a nail a free pathway for extrusion is to invite the nail to fall out of the capital fragment. In the Pugh nail this tendency has been countered by using a friction ring in the sliding sleeve which presents frictional resistance to extrusion. Any resistance offered to extrusion is theoretically objectionable because it constitutes a distraction force and will neutralise part of the compressive force of muscle-tone.

The Valgus Nail. The valgus or low-angle nail resists forces displacing it into varus by utilising support from the calcar femorale. Theoretically this is sound but the technique is not as simple as it sounds because the final position of the nail depends on the exact point

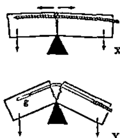


Fig 3
Beam of reinforced concrete breaking under a bending stress X the tension surface is reinforced by a steel bar bonded to the concrete thr ughout its whole length The Austin Moore wire is smooth in the greater part of its length it will be unable to reinforce the object in which it is buried because tension will avulse the point g

of entry through the lateral cortex of the femur After the point of the nail has penetrated the lateral cortex of the shaft of the femur it en counters the calcar which acts like a gutter which takes charge of the direction without the surgeon having further control

Multiple Pins Austin Moore (1903) advocated the use of four wires attempting to liken the fixation of a fractured femoral neck to the technique of reinforced concrete In structural engineering it is a first principle that a steel reinforcement should never be placed in the central axis of a concrete beam if maximum stiffness against a bending strain is desired To strengthen a beam composed of a substance as brittle as concrete steel wires are incorporated on that aspect of the beam which will be convex under a bending load but none are needed in the central axis or on the concave side This was Austin Moore s argument against using a Smith Petersen nail in the centre of the femoral neck

In reinforced concrete the iron rods bond themselves by rust or chemical action to the concrete in which they are embedded and tension in the concrete is therefore immediately communicated to the metal Wires with smooth polished surfaces would pull out of the con crete and could not act as a reinforcement unless they were specially anchored at both ends as is the case in the special instance of pre stressed concrete The Moore pin is threaded only on its outer ex tremity and the medial part is smooth so that it is incapable of resist ing tension (Fig 3)

The final criticism of multiple wires is that the neck of the femur is a thin walled tube and multiple wires must inevitably pass inside or outside the cortex In the theory of reinforced concrete the reinforcing wires would have to be totally embedded in the walls of the tube in their whole length

The mechanical theory of multiple wires therefore does not stand serious analysis

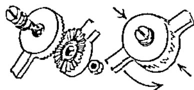


Fig 4
Well known mechanical device to resist rotation. The interdigitating teeth are the elements which resist rotation the screw is not exposed to rotatory stress The screw acts by compressing the teeth together

Screws There have been many attempts in the past to treat fractures of the neck of the femur by means of screws or bolts but without any greater success than the simple Smith Petersen nail The reason for failure in many cases has been that the screws have been used incorrectly so that they have functioned merely as nails

When a fracture is held together by a single screw the strength of the junction to resist shear and rotation depends on the frictional resistance between the opposed surfaces of the fracture If the frictional resistance is high a shearing force will be neutralised by this frictional resistance and the amount of shearing force reaching the nail or the screw will be small If no frictional resistance is present the screw or nail will be exposed to the full force of shear which will eventually cause it to cut through the bone and the fixation will become loose

The amount of frictional resistance between two objects is proportional to the force which compresses the two objects together It is obvious that a screw can compress two objects together more effectively than a nail but if a simple screw is used the compressive force resides in the elasticity of the two objects to be fixed together If a fracture is held together by a simple screw and is then subjected to violence which deflects the bone beyond its elastic limit the compressive force will not be restored when the external force is removed because the bone will have been crushed The fixation will therefore be loosened and in these circumstances a simple screw will be no more efficacious than a nail

By using spring loading in combination with a screw it is possible for the opposed surfaces still to remain under compression even though the union has been subjected to an external stress which has caused slight crushing of the bone

To illustrate the action of compression in achieving fixation a mechanical analogy is helpful The mechanical device illustrated in Fig 4 is designed to resist a rotary force The rotary force will be diffused over all the interdigitating serrations and the greater the radius of the device the smaller will be the pressure on each individual serration It is important to observe that the spring loaded nut and bolt which com

presses the two serrated surfaces together is not itself exposed to any rotary force because it is loose to turn in the device If a model of this device were to be constructed in bone we realise how futile it would be to try to hold these serrated surfaces together with a nail[1]

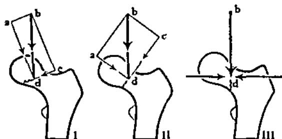


Fig 5

Pauwels Grade I Vertical force of body weight bd produces small shear force cd but large compression force ad —Pauwels Grade II Beneficial compression force ad is diminished while harmful shearing force cd is increased to comparison with Grade I—Pauwels Grade III Vertical force of body weight bd is now entirely the evil force of shear The Charnley compression screw is arranged at the most varus angle possible 120 so that the compression spring can introduce a horizontal component

MECHANICS OF SPRING LOADED COMPRESSION

The Charnley Compression Screw In this device a spring loaded compression screw is combined with a sleeve plate The angle of the sleeve plate has been purposely set at 120 and this has been criticised by surgeons who would prefer a more valgus direction of 130 or 135 The angle of 120 was chosen because it is the most varus which can conveniently be inserted into the average patient To explain the reason for choosing this varus angle it is necessary to refer to the forces acting on a fracture of the femoral neck as was first described by Pauwels In Pauwels Grade I fractures the vertical force of weight bearing generates only a small component in the harmful direction of shear (*parallel to the plane of the fracture*) *but a large component in the beneficial direction* (perpendicular to the plane of the fracture) which is the force which compresses the fragments together (Fig 5) In the Pauwels Grade II fracture the beneficial component is less and the harmful shear component greater In the Grade III fracture the beneficial force compressing the fracture together is small or even non existent and the shearing force is high It is therefore obvious that if an artificial

force with a large horizontal component could be introduced into Grade II and Grade III fractures this would increase the pressure between the fragments This is what the spring loading of the compression screw is intended to do If the screw were to be directed in a valgus direction (135 shaft neck angle) its beneficial horizontal component would be lessened and it would generate a shearing component which would increase the shearing force already present in a Grade III fracture Therefore the idea was to keep the direction as horizontal as could be conveniently inserted in order to increase coaptation in the Grade II and Grade III fractures

One of the objectives in using this compression screw which I have not previously emphasised sufficiently is to produce extreme mechanical impaction One of the commonest errors in the use of this screw perhaps fostered by the original description is to tighten the nut to the *tension of the fully compressed spring (25 lbs) and no more I now* consider that at the time of operation a much greater impacting force than this is necessary so that in the post operative period the fracture is under a compression force of 25 lbs after it has been fully impacted with a force much greater than this In this process of extreme impaction the idea is to break down any projecting spikes of bone so that the fracture is rendered stable as a result of intimate bone contact over the full area of the cross section of the neck The head of the femur is thus driven forcibly towards the blood supply existing in the base of the femoral neck

An interesting new light on the importance of intimate coaptation over the whole area of the fracture is suggested in work recently reported by Harrold (1959) which renews interest in one of the oldest theories of non union in fractures of the femoral neck It has been proved that synovial fluid inhibits the clotting of blood Harrold suggests that this could explain the failure of subcapital fractures to unite Whether or not this is the essential feature in non union of this fracture is open to argument but there is no doubt that it must be an important contributory factor If a fracture of the femoral neck can be reduced and impacted to such a degree of intimacy that synovial fluid cannot reach the fracture and cannot wash over exposed bone fragments this would seem a highly desirable objective in treatment

To achieve this extreme impaction it is essential to strain and shake the fracture while the nut is being tightened in order to make sure that the head of the femur is not perched in an unstable position on the summit of projecting bone spikes This is a technical detail of the ut

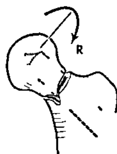


Fig 6

The ability of the tri flanged nail to resist rotation can occasionally be the cause of defective coaptation If this head were free to rotate 5 in the direction R the fracture would sink into perfect coaptation

most importance which I find is rarely adopted by many who use this device

In the mechanism of coaptation it is important to note that the essential feature of the tri flanged nail namely its ability to resist rotation of the medial fragment is a mechanical factor which can obstruct impaction Any fracture which needs to rotate in order to sink into full coaptation will be held in an unstable position by a tri flanged nail (Fig 6)

When using the spring loaded compression screw it is necessary that a sense of finality should be obtained when the nut has been fully tightened It is futile to desist from further tightening if the sensation is received that the screw is about to pull out of the femoral head The possibility of the screw pulling out of the femoral head during impaction by tightening of the nut is always present if poor resistance was encountered when the screw was inserted into the head In order to obtain a clear end point to the tightening of the nut when the femoral head is very soft a special screw has been designed with an extra large helical thread The total area of cancellous bone gripped by the thread of this screw (the life saver) is six times larger than that of the standard screw (Fig 7)

In order to make full use of this extra large screw the following technical procedure is advised –

(1) In every case start by inserting the standard screw in order to test the density of the bone of the femoral head and in order to establish the direction of the screw

(2) Delay fixation of the sleeve-plate to the shaft of the femur until the very end of the operation and insert the standard screw into the femoral head with the sleeve plate held against the shaft of the femur by an assistant

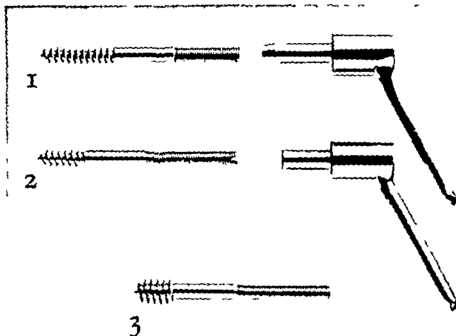


Fig 7
Showing the differences in dimensions of the original screw and sliding sleeve 1 and the final pattern 2. The special large diameter screw 3 (the "life saver") is used if the femoral head is so soft that no resistance to insertion is encountered when the standard screw 2 is used

(3) If a positive end point is obtained when the nut is tightened which holds after the fracture has been shaken and strained nothing more need be done and the operation can be completed by fixing the plate to the shaft of the femur

(4) If a positive end point is not obtained when the nut is tightened continue tightening until the standard screw is completely avulsed from the head of the femur. Extract the sleeve plate (which has not been screwed to the femoral shaft) and insert the extra large screw into the track left by avulsion of the standard screw. This track will conduct the screw into the head without the need for any mechanical guide. The sleeve plate is now threaded over the projecting end of the life saver screw and the spring and nut applied. The nut is now tightened to compress the spring and impact the fracture as before. Again it is necessary to achieve a sense of finality in tightening the nut. The plate is then anchored to the shaft of the femur to complete the operation

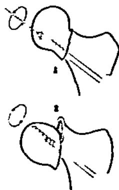


Fig 8

A central position of the screw in the head is to be preferred, but the only really bad position is a very low screw A. In this position it is possible for the screw to rotate through 180° to give the appearance B.

(5) If a sense of finality is not obtained when tightening the nut on the life-saver screw then the procedure should be abandoned and a prosthesis inserted *without any attempt at conservative treatment*

Ideal Position in Head In the original description it was stated that it did not matter whether the screw be sited centrally or eccentrically in the head Experience has shown that it is worth taking the trouble to get a centrally placed screw A screw centrally placed in the head enters a greater thickness of cancellous bone than a screw on the periphery of the head where all the helical thread may not get a purchase

An eccentric position which it is especially necessary to avoid is that which is very low in the head because this may encourage the head to rotate into a varus position with immediate loss of all spring pressure (Fig 8) The change in radiological position as a result of this rotation can be mistaken for cutting out of the screw Treatment should be immediate re-tightening of the nut of compress the head in the new position

Recent Modifications of Design Since the original description there have been four small alterations in the screw to eliminate defects which tended to obstruct extrusion and so defeat the action of continuous spring loading on the healing fracture It is important to describe these alterations so that obsolete patterns can be recognised (Fig 7)

(1) *Helical Thread* In early models the root diameter of the screw was parallel and was long and narrow the result was that the screw tended to bend and obstruct in the sleeve so preventing extrusion The present design has a short screw with a root diameter which becomes thicker towards the base



Fig. 6

(2) *Length of Sleeve* In early models the medial end of the sleeve was long and in a short neck sometimes reached the line of the fracture and this theoretically could prevent extrusion The sleeve has therefore been shortened to eliminate this possibility

(3) *Length of Machine Thread* In small patients the nut would occasionally reach the bottom of the machine thread before the fracture was completely impacted The length of the machine thread has been increased to prevent this occurrence

(4) *The Medial end of the Sleeve* This originally was tapered in order to present a fine edge to the femoral head This often became dented and obstructed extrusion of the screw by cathing the helical thread

An important feature of the design is that only one length of screw should be needed for all sizes of patients In small patients this policy may cause excessive projection of the outer end of the screw and surgeons have sometimes requested a second screw of shorter length It is undesirable to change a screw once it has been inserted to full depth because this may impair the grip of the second screw in the femoral head For this reason it is recommended that the same size of screw should be used for all patients and any excessive projection of the outer end be cut off with small fine tooth hack saw (i e Eclipse Junior) It is surprising what projection is possible without being easily palpable in patients of normal build and cutting off the projecting end is necessary only in very thin patients

Post operative Conduct The post-operative conduct is as important as the details of the operation and some bad results with this method have been due to ignoring the warning of failure as manifested by extrusion of the screw By measuring the projection of the outer end of the nut above the level of the outer surface of the sleeve plate an indication of the state of union is available which is more sensitive than any radiographic study of the bone itself (Figs 9 and 10) A radiograph should be taken every month after operation but it is unnecessary to repeat lateral films after the original post operative examination It is

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Fig 9

A original deformity B position after operation. C. 12 months after operation—showing osseous union and the emergence of the outer surface of the nut by only 1 or 2 mm (i e less than the distance between two threads of the coarse screw which is about 3 mm)





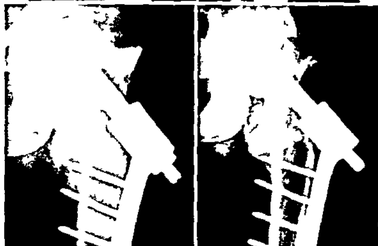


FIG. 42

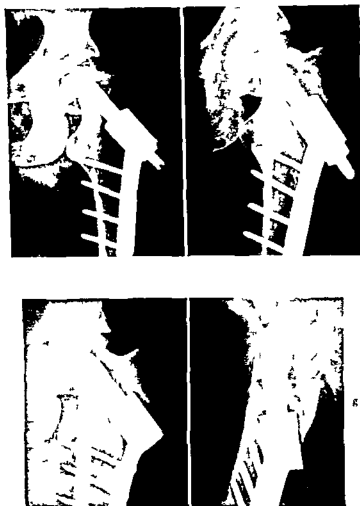


Fig 10

A original deformity of subcapital fracture B Immediate post-operative position—firm grip of screw so defective lateral position acceptable C Rapid extrusion of screw one month after operation D One week after re tightening of nut E Slight extrusion three months after re tightening but not more than about 1 mm F Screw has cut out of head but fracture appears radiologically united six months after re tightening G Screw was extracted under local anaesthesia Film shows perfect radiological union 18 months after original injury

important that the antero posterior film should be centred to show the screw in true profile and not in external rotation with the shadow of the sleeve plate markedly foreshortened

In the original description (1957) it was proved that emergence of the outer end of the nut above the level of the sleeve plate indicates absorption at the fracture line and does not mean that the screw is being avulsed from its position in the femoral head unless this is fully appreciated the whole rationale of this device cannot be understood Obviously the fracture cannot be united unless extrusion of the nut has become stationary during several monthly examinations

If *three months* after the operation the nut has not extruded *more than 3 mm* (i e the distance between two threads of the helical screw as measured directly on the X ray film) it can be considered that the fracture is united and full weight bearing can be permitted This type of case has a fully viable head and first intention osseous union has taken place (Fig 9)

If *three months* after the operation there is extrusion of *more than 3 mm* it is necessary to wait for the fourth or fifth month film to decide whether extrusion is progressive before weight bearing is permitted

If here has been *2 or 3 mm* extrusion *one or two months* after operation re-tightening of the nut should be considered (Fig 10)

Re Tightening A subject for future clinical research is the possibility of improving results by re tightening the compression spring when early extrusion indicates that pressure is being lost very rapidly In a small series where this has been done there has been no further extrusion after the second tightening and it is tempting to think that osseous union has been obtained in cases which otherwise might have failed There is no doubt that many ischaemic femoral heads are ischaemic only in parts while in other parts a blood supply is still present I visualise re tightening as encouraging the removal of defective bone until a part of living cancellous bone in the head is brought into contact with living bone on the neck

The operation of re tightening is a trivial procedure which can be done through a stab wound using local anaesthesia

Bending and Breakage of Screws Bending of the screw is not a sign of mechanical defect in the apparatus Austenitic stainless steel is essentially a soft alloy and not capable of being hardened Bending of a screw indicates that the fracture must have been in a potentially unstable position at the conclusion of the operation probably as a result of comminution of the posterior cortex and thereafter the head col

lapsed into a stable position It must be remembered that as a result of leverage a screw in the femoral neck is exposed to a shearing force of the order of 100 lbs during the simple bed exercise of straight leg raising If coaptation of the fracture surfaces is complete over the whole area of the fracture the screw will be shielded from shearing forces but if coaptation is incomplete the screw will bend

It is to be noted that no attempt has been made to design a screw strong enough to carry the whole weight of the body the purpose of the screw is to encourage osseous union of the fracture and if the screw breaks in service this means that the patient was permitted to walk on it before the fracture was united

It is inevitable that as the fracture falls together as a result of the screw bending the screw will also extrude and spring loading will be lost (Fig 11) When bending and extrusion occurs it is necessary to consider re tightening of the nut



Fig 11

Bending of the screw when fracture is fixed in an unstable position with a com minuted posterior cortex Bending of the screw without a mechanism for extrusion would result in distraction of the fragments as in 2 It is important therefore to re tighten if projection of the nut 3 accompanies bending

Fracture of the screw has occasionally been encountered In some cases there is no doubt that the surgeon has neglected the evidence of extrusion indicating that the fracture was still un united at the time weight bearing was permitted In other cases it seems possible that ischaemia of the femoral head has been absolute unlike the more com mon state of patchy ischaemia When ischaemia of the femoral head is total it seems probable that failure by any form of internal fixation is inevitable but it would seem that total ischaemia is rather rare

RESULTS

In our original report (1957) the one year results in 33 cases were available for study Twenty seven were clinically successful and six were failures (82 %) A study of a more recent series of 49 one-year -

results has now revealed a very similar figure indicating that it is possible *to cause the fracture to unite in 85 % of cases though it is ad*mitted that many of these cases will later show ischaemic collapse of the femoral head. It is possible that ischaemic collapse of the pressure-bearing area of the head may appear to be more common after this method than after the Smith Petersen nail because by use of the screw more cases proceed to union of the fracture when the head is partially ischaemic.

CONCLUSIONS

(1) The post operative management of the patient according to evidence deduced from the behaviour of screw extrusion is more important than technical detail in the operation itself.

(2) Emphasis is placed on powerful mechanical compression at the time of operation to crush the fracture until the maximum area of contact is reached.

(3) Ischaemic necrosis of the femoral head after fracture of the neck of the femur is more commonly patchy in distribution than absolute. Progressive collapse as demonstrated by extrusion of the screw is a process which should be encouraged in an endeavour to bring the living parts of the femoral head within range of the living bone in the neck fragment.

(4) The possibility of re tightening the nut in cases where rapid extrusion has occurred between the first and second months offers scope for further investigation.

SUMMARY

The mechanical efficiency of some of the methods of internal fixation in current use for the treatment of intracapsular fractures of the neck of the femur are compared with the Charnley spring loaded compression screw. This screw is intended to encourage union of the fracture by exerting a continuous compressive force in a constant direction in the absence of shearing force. It is not intended that the patient should walk on this screw before the fracture is united. Union of the fracture can be predicted by the cessation of extrusion of the screw.

It is believed that early extrusion of the screw indicates partial ischaemia of the femoral head and that by encouraging collapse if necessary by re tightening the screw it is often possible to get contact between areas of living bone which originally were separated by a

volume of partially ischaemic bone on the capital side of the line of the fracture

It is considered that the compression screw eliminates failure of union when the capital fragment is alive

A number of technical details are described which are important in minimising failure with this device

RESUME

L efficience mecanique de certaines des methodes de fixation interne couramment en usage pour le traitement des fractures intracapsulaires du col du femur sont comparees a la vis de compression Charnley avec charge ressort Cette vis tend a encourager la soudure de la fracture en exerçant une force compressive continue dans une direction constante et dans l absence d une force poussee a l extreme *Il n est pas prevu que* le malade doit pouvoir marcher avec cette vis avant la soudure de la fracture La soudure de la fracture peut etre indiquée par l arret de l expulsion de la vis On croit que l expulsion precoce de la vis indique une ischemie partielle de la tete femorale et qu en encourageant l affaissement ou si necessaire en resserrant la vis il est souvent possible de remettre en contact les surfaces osseuses vivantes qui etaient separées par un volume d os partiellement ischémique du cote de la ligne de la fracture qui se trouve vers la tete fémorale

Il est considere que la vis de compression elimine l insuccès de la soudure lorsque le fragment de la tete est en vie

Il est donne la description d un certain nombre de details techniques qui sont importants si l on veut par cette methode obtenir les meilleurs résultats possibles et minimiser les chances d insucces

ZUSAMMENFASSUNG

Die mechanische Leistungsfahigkeit von einigen der gebräuchlichen Methoden zur inneren Feststellung der intrakapsulären Schenkelhals brüche wird mit der mit einer Feder versehenen Druckschraube von Charnley verglichen Diese Schraube hat den Zweck die Vereinigung des Bruches mittels einer dauernden komprimierenden Kraft in einer unveranderlichen Richtung unter Ausschaltung scherender Krafte zu befordern Man beabsichtigt nicht dass der Patient auf dieser Schraube gehen soll ehe der Bruch geheilt ist Die Vereinigung des Bruches kann angenommen werden sobald die Austreibung der Schraube aufhort

Es ist wahrscheinlich dass die frühzeitige Austreibung der Schraube eine teilweise Ischämie des Schenkelhalses anzeigt und dass es oft moglich ist mittels Förderung des Kollapses wenn notwendig durch erneute Anstrammung der Schraube Beruhrungsflächen von lebendem Knochen der ursprunglich durch teilweise ischämische Knochensubstanz an der Kopfseite der Bruchlinie abgeschieden war herzustellen

Man meint dass die Druckschraube das Fehlschlagen der Wiedervereinigung ausschaltet wenn das Kopffragment lebensfähig ist

Eine Anzahl technischer Einzelheiten werden beschrieben die wichtig sind um die Möglichkeit des Misserfolges mit dieser Vorrichtung auf ein Minimum herabzusetzen

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FROM THE COAST HOSPITAL STAVERN NORWAY
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NOT EVERY CASE OF JUDET'S ARTHROPLASTY GIVES BAD LONG TERM RESULTS[1]

Follow-up investigation of 34 cases from 2 to 8 years after operation

By

ALEKSANDAR DODER

With the introduction of intramedullary prosthesis (Moor Thompson) in the treatment of the diseased or injured hip the indications for Judet s arthroplasty have become less numerous Judet s prosthesis is nowadays almost completely abandoned It is pointed out that the good results observed in the first year after Judet s arthroplasty are of short duration In some cases the intensity of the pain often some time was such that the Judet s prosthesis had to be removed and replaced by an intramedullary prosthesis usually about 12 to 24 months after operation For the evaluation of Judet s arthroplasty the period of observation must be long enough

REVIEW OF LITERATURE

Kirer (1952) reports very good results with the use of Judet s arthroplasty The follow up of his patients was however less than 2 years

Westerborn (1953) also thinks that with the use of Judet s prosthesis good results can be achieved even with recent fractures and pseudo arthrosis of the neck of femur Later however *Alsen* and *Olsen* (1956) from Westerborn s department after a follow up of many years made on the patients in whom Judet s arthroplasty was performed made some remarks on Judet s arthroplasty In some cases the prosthesis became less stabile looser and even broke with ensuing renewed complaints by the patients

Some other authors (*d Aubigne & Postel* 1954 *Stinchfield Copper*

[1] Paper read to the Surgical association in Oslo 11th of May 1959

man & Shea 1957 *Chistiansen & Follander* 1958) report on cases in whom complications and renewed complaints ensued for 2 years or longer after the operation These late complaints were found particularly in patients who were operated on for a recent fracture or pseudoarthrosis of the neck of femur

Gregan (1954) reports on a series of 65 recent fractures of the neck of femur where Judet s prosthesis was used and in whom the results within the first year after the operation were satisfactory When the same patients were seen 2–3 years later a deterioration was noticed in 85 % of them The X ray pictures showed shortening of neck of femur in 79 % All these cases had to be reoperated In this opinion Judet s prosthesis is not indicated in recent fractures of the neck of femur Other authors (*Guilleminet & Judet Movin, Christiansen & Fellander Hiertonn & Morscher*) agree that the application of Judet s prosthesis gave better results in arthrosis necrosis of the head of femur and pseudoarthrosis of the neck of femur (where the line of the fracture is subcapital) than in recent fractures of the neck of femur but do not give such unsatisfactory results as *Gregan* reported

Guilleminet & Judet R (1955) give the results of arthroplasty of the hip with Judet s prosthesis In 63 psedoarthroses the result was satisfactory in 66 3 % In 27 avascular necroses of the head of femur the result was even better i e good in 78 % In 29 cases wih recent fractures of the neck where Judet s prosthesis was also used good results were achieved in 65 %

Hiertonn & Morscher (1958) report the results of Judet s arthroplasty in 62 cases in whom the operation was performed 2½–8 years previously Of 7 recent fractures of the neck of femur in no single case was there an excellent result but good results were reported in 5 cases satisfactory and poor In 14 cases of the necrosis of the head of femur the results were as follows 4 excellent 6 good 2 satisfactry and 2 poor In 32 pseudoarthroses of the neck of femur the results were excellent 4 good 16 fair 4 and poor 8 Of 9 traumatic arthrites there was only 1 good 5 fair and 3 poor results

M M Shepherd (1954) gives the results of 74 cases with Judet s arthroplasty of the hip (48 cases of arthrosis 12 cases of pseudo arthrosis and 19 cases of other conditions) The follow up period was 3 years A control examination gave the following results in only 27 % was the result excellent good or satisfactory in 21 % fair or doubtful and in 52 % poor

At the end of this review we mention the analysis and statistical data

on the arthroplasty of the hip made by *R. & J. Judet* (1952) where their own prosthesis was used. Out of 219 patients with osteoarthritis in 17 % their results were excellent, in 47 % good, in 19 % poor and in 17 % bad. In 7 cases of posttraumatic arthritis as in 11 cases of long lasting septic arthritis where a dislocation occurred, good results were reported. They state that great caution and reservation should be exercised when using Judet's prosthesis for the congenital luxation of the hip though they used it 108 times in several cases with good results. As for recent fractures of the neck of femur their indications are very narrow. They suggest the use of their prosthesis only in cases of fractures possessing great predisposition for the formation of pseudoarthrosis. They are the cases where the fracture is subcapital and the head of the femur is porous. In these cases the authors had good results. Their indications for pseudoarthrosis of the neck of femur are the same as for recent fractures.

OUR MATERIAL

Our main and preferable treatment of hip joint diseases has ever been Smith Petersen's arthroplasty and most of our patients are operated upon according to his method. In the period 1–1–1952 to 17–1–1956 *in our hospital 34 arthroplasties of the hip were performed* according to Judet's method.

TABLE 1

Diagnosis, sex and age of 34 patients treated with Judet's arthroplasty

	to 20		21-30		31-40		41-50		51-60		61-70		More than 70		Total number	
	m	f	m	f	m	f	m	f	m	f	m	f	m	f	m	f
Arthrosis coxae							1	2	?	3	4	4	–	1	9	10
Pseudarthrosis colli femoris						1		1		5	1	3		1	1	11
Coxitis tbc		?				1										3
Total number		2				?	1	3		8	5	7	2	?		34

Our youngest patient was 17 years old and the oldest 76 at operation.

We must underline that many of our patients' general health was also impaired because of the long lasting disease.

Our postoperative treatment was carried out as suggested by the Judet

Brothers We have taught our patients the necessary exercises and advised them to pursue them at home as long as possible We are convinced that the success of the operation itself depends also to a certain degree on the exercises being continued correctly We are not convinced that correctly pursued complete and prolonged exercises favour loosening of the prosthesis thus making it less stabile though this may be suggested from a theoritical point of view

Complications from using Judet s prosthesis

1 Fracture of femur under operation

Once the fracture occurred during the operation Ostheosynthesis with a wire was performed The fracture healed up well it was of no significance in the final result of the arthroplasty itself

2 Formation of haematoma and wound infection

Haematoma occurred only twice after evacuation by aspiration this disappeared leaving no serious sequelae Infection of the wound occurred also twice The intensity of infection was not however such as would necessitate reoperation or discarding of prosthesis The infection involved only skin and subcutaneous tissue necrosis of the skin being only of mild degree

Local and systemic antibiotics were always sufficiently administered

3 Mortality

There was one fatal case in the first year after the operation

4 Dislocation of the prosthesis

There was no early dislocation of the prosthesis i e dislocation which occurs in the first days after operation

As for late dislocation we think that important factors leading to its development are errors during the operation (the neck of femur too short or a shallow acetabulum) and late resorption of the neck of femur and acetabulum Late dislocation occurred in 5 cases All these cases were reoperated and Judet s prosthesis was replaced by Moor s or Thompson s prosthesis

5 Resorption of the neck of femur

In connection with Judet s arthroplasty this complication is often mentioned As the neck of femur is not well vascularized trauma is easily inflicted on it If damaged no matter how it is liable to be resorbed If Judet s prosthesis is inserted into the neck of a femur which has already sustained trauma there is great probability that a considerable resorption of the neck will ensue

Consequently this complication frequently occurs with pseudo-



Fig 1

a Pseudoarthrosis of the neck of femur The line of the fracture is situated rather low Osteosynthesis with a nail had been performed earlier *b* Because of the rather low situated line of fracture the neck is at operati n left rather sh rt (20–3 19 ?) *c* After one year of satisfactory condition considerable resorpti n of the neck together with loosening and weakening of the stability of the prosthesis occurred (skiagram 17–9 19ɔ4)

arthrosis recent fractures and posttraumatic arthritis Even micro trauma and other microscopic processes in the neck of femur can have a significant role in the development of its resorption Even the slightest sign of resorption of the femur found during the operation contraindicates using the Judet s prosthesis On the basis of the relatively long follow up period of our patients the following conclusion can be made resorption of the neck is insignificant and of no influence on the final result of the operation if Judet s prosthesis is implanted in unchanged and sufficiently long neck of femur

This complication was met in 4 cases of pseudoarthrosis The line of fracture in these cases was not subcapital but rather low so that we were obliged to leave a rather short neck during the operation 3 years after the operation resorption of the neck of femur occurred to a high degree (See Fig 1) Resorption of the bone round the stem of the prosthesis occurred also at the same time which favoured even more loosening and weakening of the stability of the prosthesis The difficulties of these patients were of such an intensity that all had to be reoperated and Judet s prosthesis replaced by Moor s or Thompson s

6 Resorption of the bone around the stem of the prosthesis

Judet s prosthesis is also very often attached for this complication It is unavoidable that the stem of the prosthesis implanted in the neck of femur will reactively produce a certain resorption of the bone around itself We have found that this resorption occurs in the first months

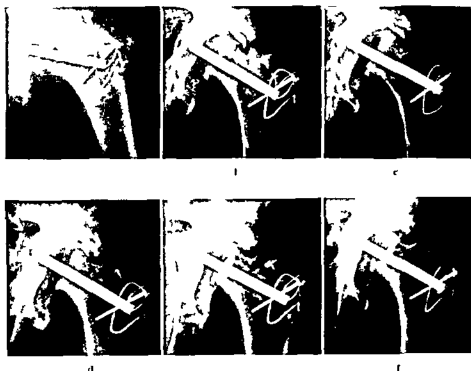


Fig 2

A series of skiagrams within 5 years after Judet's arthroplasty. *a* Immediately after the operation. *b* Two months later. The beginning of the resorption round the stem of the prosthesis is visible. *c* The skiagrams one year later. *d, e* The skiagrams some years later. *f* Five years after operation. Resorption round the stem of the prosthesis has not advanced. There is no loosening of the prosthesis nor weakening of its stability. Prosthesis introduced in a sufficiently long unimpaired and sound neck

after operation. The resorption stops at a certain degree, does not progress and has no considerable influence on the stability of the prosthesis, provided that it is introduced in a healthy, untraumatized and sufficiently long neck. (See Fig. 2)

On the contrary, the resorption around the stem of the prosthesis is progressive

7. Mechanical accidents

There was no fracture of the stem or head of the prosthesis. As for the mechanical changes of the prosthesis itself only minor erosions on the head of the prosthesis were found in all reoperated cases. In no single instance could these erosions be connected with the complaints which necessitated reoperation

RESULTS

According to the results the following 4 groups were formed excellent good fair and poor results Such a classification was made on the basis of M M Shepherd s system This system is based on the 4 main criteria for the evaluation of the results of arthroplasty of the hip and are as follows the degree of pain active mobility function by performance and the patient s own assessment of the result of the operation Tables 2 and 3 show our results of Judet s arthroplasties

TABLE 2

Results of 34 Judet arthroplasties observed for more than two years

	Number of cases						
	Years since operations						Total number
	1 to 2	2-3	3-4	4-5	5-6	6-8	
Excellent			2	1	1	3	7
Good		1	2	2	2	2	9
Fair		1	2	1		2	6
Poor		5	3	2	1		11
Dead	1						1
Total number	1	7	9	6	4	7	34

TABLE 3

Long term results of 34 Judet arthroplasties according to diagnosis

	Number of cases			
	Diagnosis			Total number
	Arthrosis coxae	Pseudarthrosis colli femoris	Coxitis tbc	
Excellent	4	1	2	7
Good	5	3	1	9
Fair	4	2		6
Poor	5	6		11
Dead	1			1
Total number	19	12	3	34

As can be seen from Table 2 the worst results fall in the period 2-3 years after the operation The reason for this is the reoperation

Died of intercurrent disease two years after operation



Fig 3

a Severe arthrosis of the right hip *b* Immediately after the introduction of Judet's prosthesis *c* Six and half years after the operation Though considerable resorption round the stem of the prosthesis exists there is no loosening and weakening of the stability and function of the extremity (See Fig 4) There is no resorption of the neck of femur

of these patients in the same period of time i e 2–3 years after arthroplasty

We come to the conclusion that the most critical time for Judet's arthroplasty are 2 3 years after the operation Late complications and complaints and difficulties usually occur in this period Recurring complication and difficulties in our patients which in Table 2 are represented as poor after the 3rd year have also appeared within the first 3 years following the operation They have been classified in the year when they were reoperated or when the last examination was carried out We have not observed that an apparent deterioration or onset of late complications ensues after 3 years of a satisfactory state with Judet's arthroplasty

Expressed in percentage long term results of our patients with Judet's arthroplasty are

excellent and good	48 5 %
fair	18 2 %
poor	33 3 %

It can be seen from Table 3 that the poorest rate results were achieved in pseudoarthrosis of the neck of femur The result was poor (50 %)

Judet arthroplasty of the hip was performed in 3 cases of coxitis t b c The long term results in all of them were very good



Fig 4

Clinical findings in a patient 7 years after Judet's arthroplasty (Fig 3 shows skiagram of this case) All movements of the hip are possible Stability of the extremity, moving and working capacity of the patient are excellent

CONCLUSION

On analysis the first thing to be noted is that 48 2 % of our patients in whom Judet's arthroplasty was performed have excellent or good long term results In some cases these results were good beyond any expectation The function and stability of the extremity personal satisfaction of the patients with the result of the operation as well as their walking and working ability are excellent though 3 to 7 years have elapsed since the operation (Figs 4 5 6)

When such good results are found after a rather long observation time we must ask ourselves whether such a method deserves to be labelled as bad and be completely abandoned We have already pointed



a b

Fig 5

a Arthrosis of the left hip *b* Five years after Judet s arthroplasty (Cup arthroplasty had been previously done but without success) *c* Clinical findings in the patient 8 years after Judet s arthroplasty Moving and working capacity of the patient stability and function of the extremity are excellent

out that one of the main indications for Judet s arthroplasty is a sufficiently long and intact neck of the femur

Angiography of the neck of femur might be helpful to demonstrate the vitality of the neck We have not carried out this method of investigation

Using any of the prosthesis which are at our disposal for resection reconstruction of the hip the late result can not be predicted (even if we adhere to indications operative technic and postoperative treatment) because each prosthesis has its pros and cons and none are ideal Each of them represents a foreign body and can not become part of the patient That is the reason why the achievement of an ideal reconstruction of the diseased or injured hip is beyond our scope

SUMMARY

Long term results in 34 patients with Judet s arthroplasty with a follow up period from 2 to 8 years are reported The fist 3 years after the operation are "most critical for the late result Patients who in the first 3 years after the operation showed a satisfactory condition did not exhibit any subsequent deterioration The main condition for a long term good result with Judet s prosthesis is its implantation in a sufficiently long unimpaired and undise of fen late



Fig 5c

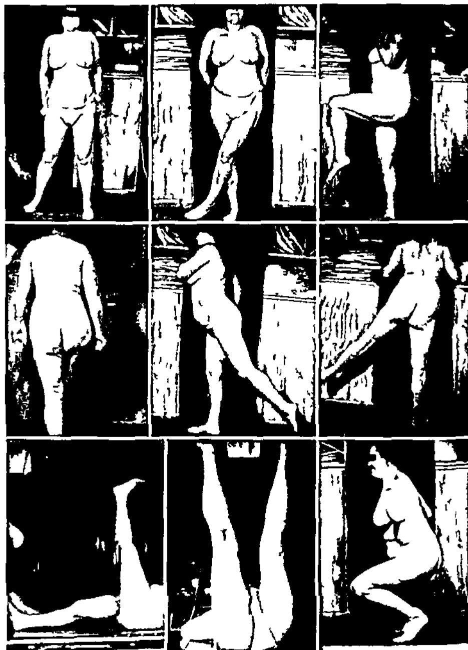


Fig 6

Clinical findings from ?3 4 19 9 in the patient in whom Judet s arthroplasty was performed on 2 10 195? because of pseudoarthrosis of the neck of femur As can be seen the result 7 ½ years after operation is excellent

results with pseudoarthrosis of the neck of femur were in 50 % poor In arthrosis the late results were better 50 % excellent and good 22 2 % fair and 27 8 % poor The author remarks that poor results were found in severe forms of arthrosis in which considerable resorption of the neck of femur and acetabulum occurred soon after the arthroplasty and in pseudoarthrosis where the line of fracture was not subcapital but rather low In 3 patients with coxitis t b c the late results were very good

RESUME

Les resultats a long terme chez 34 malades chez lesquels a ete pratiquee l arthroplastie de Judet avec une periode d observation de 2 a 7 ans sont rapportes Les trois annees qui suivent l opération sont les plus critiques pour les résultat finaux Les malades chez lesquels dans les trois années qui suivent l operation on constate un etat satisfaisant n ont manifesté aucune détérioration subséquente La principale condition pour obtenir un bon resultat a long terme avec la prothèse Judet est que son implantation ait lieu sur un col de femur suffisamment long intact et non malade Le resultat final dans la pseudarthrose du col du femur a eté piètre dans 50 % des cas Dans les cas d arthrose les résultats finaux ont ete meilleurs 50 % excellents et bons 22 2 % relativement bons et 27 8 % piètres L auteur fait observer que les mauvais resultats ont ete trouves dans les formes graves d arthrose chez lesquelles il y avait une résorption considérable du col du femur et de la cavite cotyloide apparue rapidement apres l arthroplastie et dans les pseudarthroses lorsque la ligne de la fracture n était pas subcapitale mais relativement basse Chez 3 malades avec coxite tuberculeuse les resultats finaux furent excellents

ZUSAMMENFASSUNG

Spätergebnisse in 34 Patienten mit Judets Arthroplastik und einer Beobachtungszeit von 2–7 Jahren werden berichtet Die ersten drei Jahre nach der Operation sind die kritischsten hinsichtlich des Spatergebnisses Patienten die in den ersten drei Jahren nach der Operation einen zufriedenstellenden Zustand zeigten weisen keine spätere Verschlechterung auf Die wesentliche Bedingung fur ein langdauerndes gutes Ergebnis mit der Judet Prothese ist ihre Einpflanzung in einen ungeschädigten und gesunden Schenkelhals Die Spatergebnisse in Pseudarthrosen des Schenkelhalses waren in 50 schlecht Arthrosen

gaben bessere Spätresultate 50 % ausgezeichnete und gute 22 2 % annehmbare ud 27 8 % schlechte Der Verfasser bemerkt dass schlechte Ergebnisse in schweren Fällen von Arthrose in denen bedeutende Resorption des Schenkelhalses und des Acetabulum bald nach der Arthroplastik auftrat und in Pseudarthrosen in denen die Bruchlinie nicht subcapital sondern ziemlich distal lag gefunden wurden Bei drei Patienten mit Coxitis tbc waren die Ergebnisse sehr gut

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FROM THE ORTHOPAEDIC DEPARTMENT IN JÖNKÖPING
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THE SIGNIFICANCE OF CONGENITAL PES CALCANEO VALGUS IN THE ORIGIN OF PES PLANO VALGUS IN CHILDHOOD

Preliminary report

By

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A number of authors (*Erlacher, Gocht, Mau, Timmer* etc.) have indicated that congenital pes calcaneo valgus can give rise to pes plano valgus when the children begin to bear weight. Clearly this is not a question of the rare congenital plano valgus flat foot which shows severe abduction and extention of the forefoot, with the head of the talus standing plantar luxated and with even plantar flexion of the calcaneus.

In congenital pes calcaneo valgus the foot lies against the lower leg or can be extended without resistance until it impinges against the leg. In so doing no luxation occurs in the talo navicular joint and the calcaneus accompanies the extension. In the pronounced cases of pes c.v.-c one finds a spontaneous abnormal valgus position of the heel. In other cases the valgus is first demonstrable with maximum extension of the foot. Abduction of the forefoot is usually of mild degree. In contrast to the congenital pes plano valgus, the foot can be restored to a normal position without great resistance. Plantar flexion occasionally is reduced.

The frequency of pes c.v.-c among newborn children is reported to be over 30 %. The figures vary and even over 50 % is reported. Early treatment in infancy has been proposed with fixation of the feet in plantar flexion and supination in order to eliminate the abnormal calcaneo-valgus position and to prevent the development of pes plano valgus when the children begin to walk.

No follow up examination of congenital calcaneo valgus feet until the weight bearing age seems to have been made Such a study could show with certainty whether the occurrence of pes plano valgus among these children is greater than in a control group Moreover there is no study regarding the value of the proposed treatment that is if in addition to correcting the calcaneo valgus position it also prevents the appearance of pes plano valgus in the weight bearing age

To answer the question of the significance of pes calcaneo valgus congenitus in the origin of pes plano valgus the orthopeadic department in Jonkoping with the cooperation of the obstetrical department has examined all the newborn children during a two year period (1946–1948)

The signs of congenital calcaneo valgus have been differentiated in the following way

Valgus

The feet are examined from behind The angle of spontaneous valgus position is measured in degrees between the long axis of the leg and the heel by means of a transparent protractor In this case (Plate no 1) there is no obvious valgus position



Plate no 1

Next the foot is dorsiflexed maximally that is the forefoot is forced up as far as possible against the lower leg Plate no 2 shows that a 10 valgus is produced in the heel of the right foot

To test for maximal valgus the heel is pushed laterally by pressure on the medial side and at the same time the forefoot is held extended and forced laterally that is into abduction In this position the maximum valgus is produced

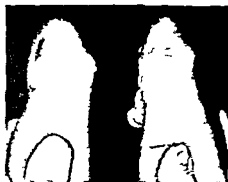


Plate no 2



Plate no 3

Hyperextensibility

The knee joint is extended and the forefoot is forced against the leg as far as possible (Plate no 4)



Plate no 4

Plantarflexion

The foot is plantarflexed and care is taken that the heel accompanies the movement (Plate no 5) Plantar flexion of at least 50 is considered normal



Plate no 5

Abduction of the forefoot

The plantar aspects of the feet are examined while the ankle and subtalar joints are held in neutral position Even with a slight degree of abduction a convex medial bulging occurs at the level of the talo navicular joint (Plate no 6) Greater degrees of abduction can be measured by the angle between the long axes of the forefoot and hind foot

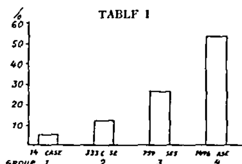


Plate no 6

The total number of newborn infants examined was 2735 The findings of congenital pes calcaneo valgus among these infants have been divided into three groups with the degree of maximum valgus as the determining factor

Group 1 consists of cases with valgus of 20 and over group 2 of between 10 and 15 and group 3 of valgus up to 5 (and uncertain valgus) and group 4 all the newborns with no signs of pes calc valg con (see table 1)

TABLE 1



All cases with any degree of pes calcaneo valgus cong were requested to come for examination until a little more than a hundred in groups 1 to 3 had been collected Thereafter only the pronounced cases belonging to group 1 were sent for Division of the cases into three groups was undertaken in order to separate with certainty the important from the unimportant findings A random picked control group was later chosen out of that part of the whole material which showed no signs of pes calc valg cong (fourth group) The comparison of the frequency of pes plano valgus in the weight bearing age ought to give an idea if any significant difference is developing between group 1 and group 4

Conclusions regarding the weight bearing appearance are more uncertain than described above in infants especially where children of one year old are concerned The often markedly developed fat pads particularly complicate an opinion regarding the longitudinal arch

The findings in pes plano valgus have been graded in the following way

Marked degree of pes plano-valgus

a Valgus of some degree and complete flattening of the long arch on standing

b Valgus of 10 or more on standing and some degree of depression of the longitudinal arch

Moderate degree of pes plano-valgus

Up to 5 valgus on standing and moderate depression of the longitudinal arch

Uncertain findings

Only an intimation of valgus or flattening of the long arch (uncertain findings) and otherwise clearly unremarkable feet

Despite the relatively large risk of uncertainty using the above criteria a sufficiently large difference should be found between cases with an important degree of pes plano valgus and those with normal feet (or uncertain findings)

An objective examination for measuring the degree of the abnormal weight bearing position is of course very desirable This has been done successfully by *Schwartz* and *Health* and later by *Karpovitch* and *Wilklow*

A new method based on a strain gauge is at present being tried by the author

A preliminary report is given here of a follow up examination of one year old children who had recently begun to walk and also of children of two years of age Yearly control until the age of four or five is clearly necessary to obtain a comprehensive idea of the development of the feet

Table II shows the frequency of pes plano valgus at one year of age in the groups 1 to 4 in percentage columns Table III shows the frequency at two years of age

Tables II and III reveal that children with calcaneo valgus feet of severe degree in infancy (group 1 20 of valgus or more) show a significantly higher percentage of pes plano valgus at one year of age (42 6 %) when compared to those children who were normal in infancy (group 4 9 5 %)

This difference in frequency decreases markedly at two years of age because the previously normal children (group 4) present an increased number of pes plano-valgus (23 8 %) whereas group 1 continues unchanged (43 1 %)

Children with mild degrees of calcaneo valgus feet (group 3 up to 5 valgus) continue almost completely the same as group 4 which consists of children with no signs of pes calcaneo valgus congenitus Group 2 with moderate findings of calcaneo valgus in infancy (10–15 valgus) lies closer to group 1

TABLE II
Examination at one year of age

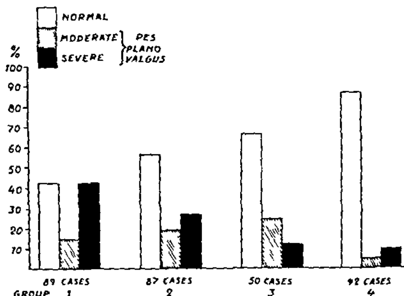
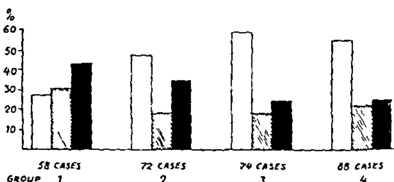


TABLE III
Examination at two years of age



SUMMARY

Pes calcaneo valgus congenitus of severe or moderate extent seems to hold an increased risk of later pes plano valgus. The difference in comparison with a random picked control group is relatively large at one year of age (42 % against 9 %) and decreases remarkably at two

years of age (43 % against 23 %) for the reason that the control group shows an increasing frequency of pes plano valgus

It remains to be seen if any essential difference in frequency will be found with later follow up examinations

RÉSUMÉ

Le pied bot calcanéen valgus ou congenital d'étendue grave ou modérée paraît comporter un risque accru de pied plat valgus ultérieurement. La différence avec un groupe de contrôle choisi au hasard est relativement importante à l'âge d'un an (42 % contre 9 %) et diminue notoirement à l'âge de deux ans (43 % contre 23 % pour) la raison que l'on observe dans le groupe de contrôle une fréquence accrue du pied plat valgus

Il reste à voir si l'on trouvera une différence essentielle de la fréquence à des examens ultérieurs

ZUSAMMENFASSUNG

Pes calcaneo valgus congenitus schweren oder mässigen Grades scheint eine erhöhte Gefahr eines späteren pes plano-valgus in sich zu tragen. Der Unterschied im Vergleich mit einer Kontrolgruppe ist im ersten Lebensjahre verhältnismässig gross (42 % gegen 9 %) aber nimmt im zweiten Lebensjahre bedeutend ab (43 % gegen 23 %) da die Kontrolgruppe eine zunehmende Häufigkeit von pes plano valgus aufweist

Es bleibt zu sehen ob bei späteren Kontrolluntersuchungen ein wesentlicher Unterschied zwischen diesen Gruppen gefunden wird

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FROM THE CLINIC FOR ORTHOPAEDICS AND TRAUMATOLOGY, UNIVERSITY CENTRAL HOSPITAL, HELSINKI (CHIEF: PROFESSOR K. E. KALLIO)

FEMORAL MUSCLE HERNIA ORIGINATING AT THE SITE OF REMOVAL OF A FASCIA LATA TRANSPLANT AND REPAIRED WITH SKIN

By

ANTERO HUSA

Muscle hernia in the sense of herniation of muscle tissue through an opening in the fascial sheath is fairly rare. It usually occurs in the lower extremity, mostly in the region of the leg. The size of the hernia varies. Some are large, but most are c. 3 cm. in diameter or smaller. Trauma may cause the laceration of the fascial sheath and the protrusion of the muscle through the opening, but it is often impossible to establish a causal relationship with trauma (1).

The hernia most commonly encountered in the leg is small, multiple, often bilateral. It probably originates at congenitally weak spots in the sheath, e.g. at points where the small arteries, the veins or the cutaneous nerves push through it. Recurrent muscular strain seems to be one cause in the genesis of hernia, for the majority of the cases occur in athletes and soldiers (9).

Muscle hernia requires treatment only if the symptoms cause the patient obvious inconvenience (1, 2). Therapy consists of closing the opening in the fascial sheath by suturing or fascia transplant (9). Excision of the protruding part of the muscle followed by suturing of the muscle and closing the opening in the sheath has also been used as the treatment (2).

Skin has been found a suitable reconstruction material in animal experiments (3, 6, 10) and in several clinical cases. This method has been applied, for instance, in the treatment of inguinal and umbilical hernias (8).

Skin has been used at the Clinic as interposition material in articular operations (4, 5) and also in various reparative operations, e.g. in lacerations of the Achilles tendon and in ligament lacerations of the knee

In the animal experiments the skin graft in tendon repairs has had an average spontaneous stretch value of c 28 per cent and in eight weeks it assumes practically the strength of a normal tendon (3)

The case reviewed here involved a major postoperative femoral muscle hernia which was repaired by skin graft

A labourer of 47 was admitted for treatment at the Clinic on October 7 1958 He had been wounded in the face in 1939 by a rifle bullet. In addition to other traumas his right hand facial nerve was paralysed Fascioplasty was done c six months later on the face because of the facial paralysis The material for this plastic operation was taken from the fascia lata of the right thigh The site of removal of the fascia healed well after surgery but four years later on lifting a heavy stone the patient developed muscle hernia there The hernia gradually grew and became painful on movement and at work He was consequently almost completely incapacitated for heavy work. Especially in the winter it was difficult to walk and work in the snow

The patient was small in stature of normal physique There was complete right hand facial paralysis and the region of the right ear was deformed Nothing noteworthy was observed in the circulatory respiratory and alimentary organs

The patient s gait was fairly normal In the right thigh there was laterally an operation scar 20 cm in length The site of the scar lay on an extensive bulge which appeared more clearly in the standing position when the femoral muscles were tautened (Figs 1–3)

Operation for hernial repair was performed on October 9 1958 A defect length 30 cm and breadth 10 15 cm was found in the fascia lata and the healthy looking m vastus lateralis bulged through it The margins of this gap were drawn together with difficulty by chromium catgut and steel wire sutures The suture line was very tight at places and since it was not expected to hold a whole-thickness skin graft measuring c 5 × 25 cm was taken from the edge of the wound and used as reinforcement The skin graft epidermis removed was stretched tight and fastened by chromium catgut sutures over the suture line with the subcutaneous part against the fascia (Fig 4) The skin wound was closed by silk sutures

Three weeks after the operation the patient was permitted to move around on crutches The skin sutures were removed and the patient was discharged Partial loading of the operated extremity was started 6 weeks postoperatively and after 7 weeks the patient was allowed to move about freely

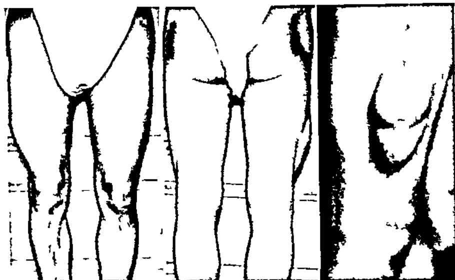


Fig 1 *Fig 2* *Fig 3*

Figs 1–3
Mu cle hernia pre-operatively

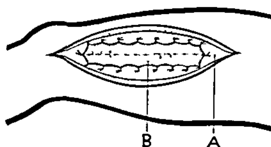


Fig 5
A Fa cia lata the defect suture l edge t edge
B The kin graft fa tened acr the uture line f the fa cia lata

At the follow up 8 weeks after surgery the wound w as found to have healed perfectly the plastic repair had held well (Figs 5–7) The sub jective symptoms had disappeared the only complaint being that the patient still had an occasional slight sensation of tightness in the dist al part of the femur Some 7 months postoperatively asked by letter about his condition the patient replied that the pl astic reconstruction was secure

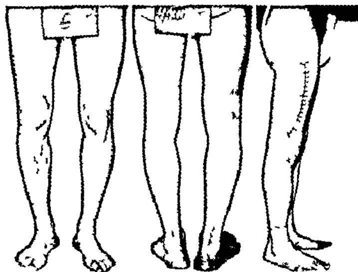


Fig 5 *Fig 6* *Fig 7*

Figs 5–7
Status 8 weeks postoperatively

The sudden heavy strain that the lifting involved had obviously caused a rupture of the place in the fascia lata weakened in an earlier operation and resulted in the muscle hernia.

According to *Lexer* and *Baus* (7) a muscle hernia diminishes or disappears completely when the muscle is tautened provided that it is intact. If the muscle is damaged, stretching it causes enlargement of the hernia. It is possible that the present case involved a hernia of the latter type although no fault in the muscle was established on operation.

The hernial repair was easy to perform by skin graft despite the wide fascial defect. The plastic reconstruction was sufficiently strong after 8 weeks to permit full weight bearing. Although the observation time was short, the good result suggests that the method can probably be employed again in the future.

SUMMARY

Fascia lata has not been used as reconstruction material in the last few years at the Clinic for Orthopaedics and Traumatology, University of Helsinki. It has been replaced by full thickness skin. The removal of a fascia lata graft may result in complications. The author reports a case in which a large muscle hernia had originated at the site of

removal of a fascia lata graft The extensive defect in the fascia lata was closed by a full thickness skin graft epidermis removed taken from the edge of the wound Partial loading of the operated limb was started after 6 weeks and the patient was permitted to return to work after 8 weeks Follow up examination showed the plastic reconstruction to be secure

RESUME

Le fascia lata n a pas ete utilise comme materiel de reconstruction durant les derniers cinq ans par la Clinique d Orthopedie et de Traumatologie de l Universite d Helsinki Il a ete remplace par de la peau dans toute son épaisseur Il peut resulter des complications de l enlevement d une greffe de fascia lata L auteur rapporte un cas dans lequel une large hernie du muscle s est formée du coté ou la greffe de fascia lata a eté enlevee La lesion extensive du fascia lata a ete fermee par une greffe de peau dans toute son epaisseur l epiderme transplante ayant ete preleve en bordure de la blessure Au bout de six semaines on permit une charge partielle du membre opere et au bout de 8 semaines le malade put reprendre son travail Des examens ulterieurs ont montre que la reconstruction etait assuree

ZUSAMMENFASSUNG

Fascia lata wurde in den letzten Jahren an der orthopadischen und traumatologischen Klinik der Universitat in Helsinki als Wiederherstellungsmaterial nicht mehr benutzt Sie wurde durch Vollhaut ersattet Die Herausnahme eines Fascia lata Stückes kann von Komplikationen gefolgt sein Der Verfasser berichtet uber einen Fall in dem eine grosse Muskelhernie an der Entnahmestelle der Fascia lata entstanden war Der ausgedehnte Defekt in der Fascia lata wurde mittels eines vom Wundrand entnommenen Vollhauttransplantates bei dem die Epidermis entfernt worden war geschlossen Teilweise Belastung des operierten Gliedes wurde nach 6 Wochen begonnen und der Patient durfte nach 8 Wochen wieder arbeiten Die Nachuntersuchung zeigte dass die plastische Wiederherstellung gehalten hatte

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Announcement



The Orthopaedic clinic of Karolinska Institutet opened in 1935 171 beds

EDITORIAL NOTE

KAROLINSKA INSTITUTET in Stockholm will celebrate its 150th anniversary in December 1960 As a token of the importance the *Institut* has had for our journal and for orthopaedics in Scandinavia the editors of the *Acta Orthopaedica* wish to dedicate this volume to the *Institut* All of the contributors have at some time or other been linked to the *Institut* As an Introduction Professor Sten Friberg has given a short outline of the birth of the Institut its past achievements and the rank it occupies today in the world of science

ACTA ORTHOPAEDICA congratulates the Institut and hopes that the journal will be able to enjoy its stimulating support and co-operation in the future

FROM THE STATE VETERINARY INSTITUTE AND THE DEPARTMENT OF PHARMACOLOGY ROYAL VETERINARY COLLEGE STOCKHOLM

UPTAKE OF S^{35} IN THE INTERVERTEBRAL DISCS AFTER INJECTION OF S^{35} SULPHATE
AN AUTORADIOGRAPHIC STUDY

By

H J HANSEN and S ULLBERG

In autoradiographs from sections through whole mice injected with S^{35} sulphate an uptake of S^{35} was noted in the peripheral zone of the nucleus pulposus (fig 1) The study to be described in this paper with newborn piglets as experimental animals was undertaken in order to localize radiosulphur in the intervertebral discs more precisely and to follow the changing autoradiographical distribution patterns over a period of time The method might be useful when studying the meta bolic alterations in different morphological structures appearing with ageing or as the result of degeneration in intervertebral discs

METHODS

The radiosulphate was produced by neutron irradiation of ana lytically pure potassium chloride in the uranium reactor of AB Atom energi Stockholm according to the reaction Cl^{35} np S^{35} Purification of the radiosulphate formed was carried out according to methods described by *Deshpande* (1959) (3) Radiochemical purity was tested by paper chromatography

Five piglets were injected intraperitoneally with a dose of 1 mC car rier free S^{35} sulphate per kg body weight The pigs were littermates and when injected they were about 24 hours old with an average weight of 1 9 1 g

After injection they were killed at intervals of 1 5 hours 6 hours 24 hours 4 days and 16 days At the end of the experiment the piglets weighed 1 9 1 8 1 9 3 and 7 1 g respectively

Immediately after the animals were killed a portion of the lumbar

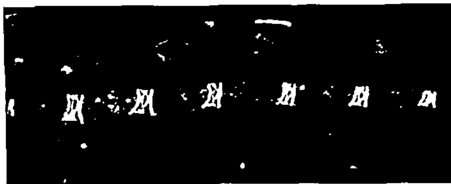


Fig 1
Distribution of S^{35} in the vertebral region of an adult mouse 24 hours after the intravenous injection of S^{35} sulphate

vertebral column was removed and rapidly frozen by immersion in a solid mixture of carbon dioxide and acetone Sagittal sections 20 μ thick were then prepared in a refrigerated room at —10 C The sections were freezed dried and autoradiographical exposure was made by apposition at —10 C against Gevaert Dentus x ray film More extensive descriptions of the autoradiographic technique have been given previously (16 17) The exposure time varied from 5 days for the pig killed 1.5 hours after injection to 60 days for the pig killed after 16 days

RESULTS

One and a half hours after the injection of S^{35} (fig 2) radioactivity is apparent throughout the entire specimen In the vertebral bodies activity is greatest in the epiphyseal lines and periosteum while in the osseous tissue the trabecular structure is clearly delineated With the exception of the vascular channels there is uniform uptake throughout the epiphyseal cartilage and since the activity is somewhat stronger than in the annulus fibrosus the border between these structures is quite distinct In the annulus activity increases slightly towards the inner portion With its moderate and diffuse activity the nucleus pulposus contrasts with the cartilage plate Activity in the nucleus is nevertheless somewhat greater towards the periphery

Six hours after the injection of S^{35} (fig 3) activity is more distinctly concentrated to the epiphyseal cartilage the inner portion of the annulus and the periphery of the nucleus Activity along the epiphyseal line is no longer so much more evident than in the epiphyseal cartilage



Fig 2

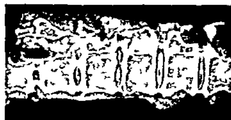


Fig 3



Fig 4



Fig 5



Fig 6

Figs 2–6

Distribution of S^{35} in the lumbar vertebral column of piglets at the following intervals after intraperitoneal injection of S^{35} sulphate

Fig. 2 1 5 hours Fig 3 6 hours Fig 4 24 hours Fig 5 4 days Fig 6 16 days

One day after injection (fig 4) the appearance has changed radically with nearly complete disappearance of activity from the diaphysis of the vertebral body and concentration in the three sites already mentioned the epiphyseal cartilage the inner zone of the annulus and the periphery of the nucleus

By four days after injection (fig 4) radioactivity has largely disappeared from the vertebral body apart from the periosteum and the primary spongiosa adjacent to the epiphyseal line Activity in the epiphyseal cartilage the inner zone of the annulus and the periphery of the nucleus is by now impressive while activity has largely disappeared from the other regions There is no clear distinction ventrally and

dorsally between the inner portion of the annulus and the periphery of the nucleus. Between the nucleus and the cartilage plate (or more correctly at this stage the epiphyseal cartilage) there is a distinct border line. Activity appears in thin lines radiating from the periphery of the nucleus in towards its centre.

Despite a much longer exposure time for the autoradiographs made 16 days after injection (fig. 6) the images are quite weak. The most important difference is seen in the nucleus. A distinct concentration of activity is still apparent at the periphery and in addition to this there is obvious although much weaker activity in the central part of the nucleus.

DISCUSSION

Within the nucleus a series of morphological, chemical and physical changes take place throughout life. The gelatinous, semifluid state of the newborn nucleus becomes successively dehydrated with metamorphosis of this structure generally fibroid, in some instances chondroid. Systematic morphological studies on dogs have demonstrated that this metamorphosis originates at the periphery of the nucleus and the inner layer of the annulus fibrosus, so intimately associated with the nucleus in this species (11). In this region there is vigorous cellular activity. The most important chemical property of the nucleus is its content of polysaccharides. According to *Malmgren & Sylven* (1952) (12) these polysaccharides consist of chondroitin sulphate or sulphate isomers. In a series of papers *Cardell* (7–10) has demonstrated that both chondroitin sulphate and keratosulphate are present, a finding which has been confirmed by others (2). *Dziewiatkowski* (1951) (4) and *Bostrom* (1952) (1) have shown that S^{35} labelled sulphate is taken up by cartilage mainly as ester sulphate in chondroitin sulphuric acid. Radiosulphur can also be recovered from keratosulphate (*Roden* 1956) (15).

The manner in which S^{35} was incorporated in the nucleus pulposus in our experiments with mice and newborn piglets indicates that synthesis of the two sulphomucopolysaccharides of interest takes place in the peripheral zone. This synthesis is apparently preceded by at least a day long period during which the sulphur is diffusely distributed throughout the disc cartilage and bone. *Friberg* (1958) (6) observed that in guinea pigs sulphur is present in inorganic form up to 48 hours after injection. Inorganic sulphur in bone has also been observed by *Engfeldt et al.* (1951) (5).

Activity was low 16 days after the injection of S^{35} largely because the rapidly growing piglet diluted the injected sulphur Activity in the central portion of the nucleus at this time can be interpreted in two ways Either the S^{35} polysaccharides have already degraded to give inorganic S^{35} or else polysaccharides have migrated from the periphery of the nucleus the question remains open

In this experiment on newborn piglets the incorporation of radio sulphur illustrates the metabolically most active components in the intervertebral space—the periphery of the nucleus the inner portion of the annulus and the epiphysis of the vertebral body Metabolic activity has its morphological counterpart In the autoradiograms there is no distinction between the ventral and dorsal parts of the nucleus and the adjacent inner portion of the annulus In like manner there is intimate union between the inner layer of the annulus and the epiphyseal cartilage of the vertebral body On the other hand the border is very distinct between nucleus pulposus and the cartilage plate the portion of the epiphysis of the vertebral body abutting upon the disc

Whether one examines a histological section or an autoradiogram the inference is the same—that the tissue layers which form the periphery of the nucleus and the perinuclear portion of the annulus represent the growth zone of the disc Here is the seat of the fibroid or chondroid metamorphosis of the nucleus pulposus and here it appears the synthesis of the mucopolysaccharides takes place An echo of embryological development can be discerned Chorda dorsalis forms the centre of the future disc and at an early stage is enclosed by pericordal precartilage The definitive nucleus is formed by combined development of the chorda and the inner portion of the annulus derived from the perichordal pre cartilage (13 14) It is only to be expected then that the persisting growth zone of the nucleus is situated about its periphery

SUMMARY

S^{35} injected as sulphate intraperitoneally into newborn piglets is concentrated in the intervertebral space to the epiphyseal cartilage the inner zone of annulus fibrosus and the periphery of nucleus pulposus As a probable expression of synthesis of the sulphomucopolysaccharides the incorporation of S^{35} at these sites accords closely with inferences deduced from morphological features

To obtain distinct autoradiograms of S^{35} incorporation at least one day should elapse after injection

RESUME

S^{35} en injection intraperitoneale comme sulfate chez des porcelets nouveaux nes se concentre dans l espace intervertebral jusqu au cartilage epiphysaire la zone interieure de l anneau fibreux et la peripherie du noyau pulpeux Comme l expression probable d une synthese de sulfomucopolysaccharides l incorporation de S^{35} dans ces endroits concorde parfaitement avec les conclusions tirees des faits morphologiques

Pour obtenir des autoradiogrammes distincts de l incorporation de S^{35} wenn als Sulphat in die Peritonealhohe von neugeborenen

ZUSAMMENFASSUNG

S^{35} wenn als Sulphat in die Peritonealhöhle von neugeborenen Ferkeln injiziert wird im Zwischenwirbelraum des Epiphysenknorpels der inneren Zone des annulus fibrosus und der Peripherie des nucleus pulposus gespeichert Als ein moglicher Ausdruck der Synthese von Sulphomucopolysacchariden stimmt die Einverleibung von S^{35} an diesen Stellen mit Folgerungen die aus morphologischen Erscheinungen gezogen werden nahe überein

Um deutliche Autoradiogramme von S^{35} Einverleibung zu erhalten sollte zumindest ein Tag nach der Injektion verstrichen sein

ACKNOWLEDGEMENTS

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FROM THE ORTHOPAEDIC CLINIC KAROLINSKA INSTITUTET STOCKHOLM (HEAD PROFESSOR STEN FRIBERG) AND FROM THE DEPARTMENT OF FUNCTIONAL ANATOMY OF THE PHYSIOLOGICAL INSTITUTION GYMNASTISKA CENTRALINSTITUTET STOCKHOLM (HEAD DOCENT S CARLSÖÖ)

A NEW METHOD FOR ASSESSMENT OF THE STATIC AND DYNAMIC WEIGHT BEARING OF THE FOOT

(*Preliminary Report*)

By

H WETZENSTEIN

In judging the weight bearing of the foot the examiner is limited chiefly to the findings on inspection which give him a rather subjective impression of the nature and severity of the possible abnormality This uncertainty is especially evident when comparing the findings at different times Subjective assessments of this kind can hardly be used in a scientific investigation

With even less certainty can the examiner form an opinion of the weight bearing when the foot is hidden in a shoe It is therefore difficult to judge objectively the value of for example arch supports and similar corrective measures

The several measuring methods which have been published are concerned with an objective registering of the load on the foot (Abramson Carlet Eberhart and Inman Holden and Muncey Schwartz and Heath and others) These methods are partly very complicated and partly unsuitable for a special study of the weight bearing in shoes

The author has therefore developed a new method for the qualitative and quantitative measurement of the foot s weight bearing in shoes

The basis for this method is the load as it spreads itself out over the weight bearing surfaces of the foot The point of resolution of the weight bearing load which corresponds to the point of action of the load on the weight bearing surface migrates over the foot during a step from the heel to the forefoot The purpose of the study is to determine if the movements of the weight bearing load are sufficiently significant to allow a delineation of different types of weight bearing

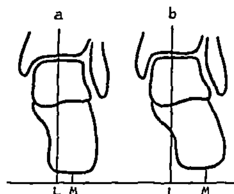


Fig 1
Schematic sketch of the medial deviation of the load with valgus weight bearing (b)
L = Load M = middle point of the heel

Fig 2
The measuring instrument built into the heel of the shoe The heel cap is partly cut away to show the position of the instrument

Fig 1 shows schematically the medial deviation of the load with for example valgus weight bearing

In collaboration with Arne Soderholm engineer from the Royal Institute of Technology in Stockholm a measuring plate has been con



Fig 3

The dismantled instrument At the bottom the cantilever construction on the left before and on the right after gluing on the strain gauges

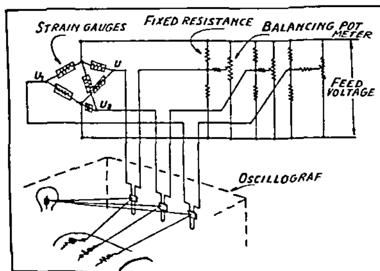


Fig 4

Circuit diagram of the measuring instrument zero balance device and oscillograph (mirror galvanometer)

structed which registers the vertical load through the heel region The plate is countersunk in the heel of the shoe (Fig 2)

The measuring apparatus is made of a stiff spring balance consisting of a plate which is carried by three cantilevers On each cantilever are mounted two strain gauges one on the upper side and one on the lower side (Fig 3)

The cantilevers have a certain flexibility and it is this deflection during loading by force which influences the strain gauges. The resistance-changing produced in them are directly recorded by means of mirror galvanometers (Visicorder).

Fig. 4 gives schematically the electrical circuits.

With the help of the three curves which are obtained the total vertical load (P) is calculated and also the point of action of the load (by means of α and β) according to the formulae

$$P = \frac{h}{E}(L_1 + L_2 + L_3)$$

$$\alpha = \frac{L_1 - \frac{1}{2}(L_2 + L_3)}{L_1 + L_2 + L_3} \cdot L$$

$$\beta = \frac{\frac{\sqrt{3}}{2}(L_2 - L_3)}{L_1 + L_2 + L_3} \cdot L$$

Where

h = Calibration factor E = Supply voltage L = Tracing of the curves in mm
L = Measuring Constant (in this case amounting to 22)

α, β and P are calculated for every load phase over the heel at 9 points spaced at equal times over the curves (Fig. 5).

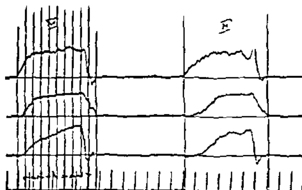


Fig. 5

An example of the curves from the oscillograph (Visicord) with the tracings (L_1, L_2, L_3) from two phases of weight bearing. The short vertical marks at the bottom of the figure denote tenths of a second.

α represents transference of the load from the Y axis in the anterior posterior direction and β from the X axis in the lateral or medial direction (Fig. 6).

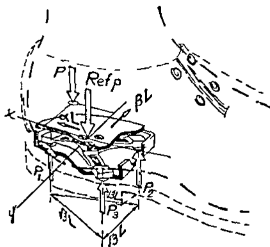


Fig 6
Schematic sketch of the measuring instrument in the heel of the shoe with the Y and X axis indrawn

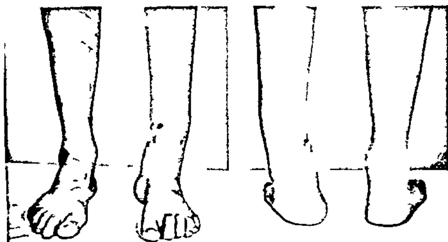


Fig 7
Patient with pseudarthrosis of the left tibia with varus weight bearing

By summation of the α and β tracings one obtains a resolution which corresponds to the point of action of the load Throughout the weight bearing on the heel during a step that is from the first setting down of the heel until the load is a characteristic migration of this point of action from the back to the front of the heel region This migration can

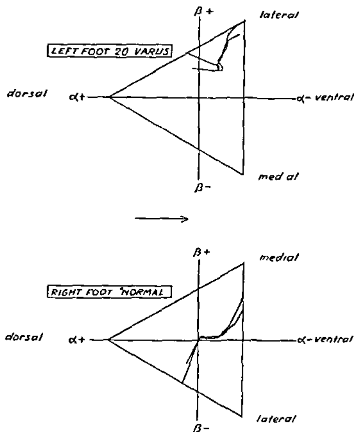


Fig 8

The diagram shows the varus weight bearing on the left foot with the points of action of the load falling laterally

be set in relation to the total vertical load (P) and to the lapse of time which can be read off in tenths of a second

After calibration of the sensitivity of the instrument trial measurements were performed on a number of experimental subjects with various degrees and types of abnormal weight bearing and also some with no apparent abnormalities according to clinical assessment The measurement examinations were performed on standing and walking the latter on a treadmill

To illustrate the possibilities of the method the result obtained on examination of a patient with an obvious varus position of the left foot (over 20) is shown (Fig 7) Varus weight bearing resulted from a pseudarthrosis of the tibia immediately above the ankle joint The right foot was clinically normal

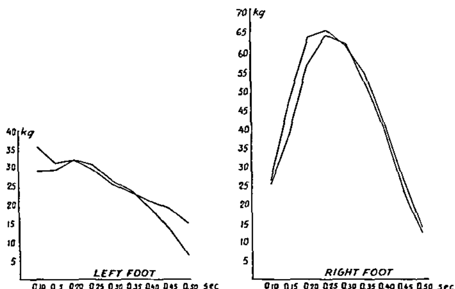


Fig 9

Diagram of the total vertical load in kilograms for the steps shown in Fig 8
The patient s weight 73 4 kilograms

The diagram (Fig 8) shows the triangular shaped calibration areas on the measuring plates for the left and the right heel The line which runs from dorsal to ventral ($+\alpha$ to $-\alpha$) corresponds to the x axis and the line from lateral to medial ($+\beta$ to $-\beta$) to the Y axis The arrow represents the direction of walking With the help of the α and β values the resolution points of the load have been inserted and connected so that they are represented by lines Two different steps have been recorded and each line in the diagram represents one step As expected the varus foot s weight bearing points fall laterally The normal foot s weight bearing migrates from laterally to medially This measurement was done with the patient walking at a speed of 4 kilometers per hour on a treadmill The step frequency was 116 per minute The weight bearing on the heel lasted from about 5 to 7 tenths of a second

In the following diagram (Fig 9) the magnitude of the load with regard to the vertical component only is shown for the same step in kilograms It is clearly shown that the heel of the varus foot bears less weight This agrees with the obvious clinical limp

To illustrate the differences between varus and valgus weight bearing as it appears in the curves a diagram is now shown in which the β values from four examination subjects are assembled for comparison

(Fig 10) The β curves show to what extent the load fell medial or lateral to the measuring plates middle line (X axis) In the diagram only the left foot of each subject was recorded and two steps are represented The degrees of valgus or varus weight bearing have been estimated by clinical examination and are approximate The curves show clearly the obvious fact that varus feet take more weight on the lateral side and valgus feet take more weight on the medial side

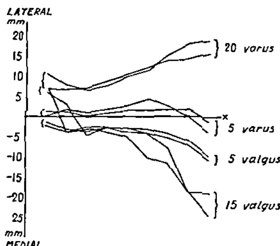


Fig 10
Diagram illustrating the differences between varus and valgus weight bearing on the left foot of four subjects

SUMMARY

A new method has been developed for recording the dynamic and static weight bearing of the foot in a shoe The vertical component of the load is measured in the heel region For this purpose a stiff spring balance is used in which the deflection is registered by strain gauges

The resolution of the weight bearing load which corresponds to the point of action of the load on the weight bearing surface migrates over this surface in a characteristic way during the weight bearing phase of a step Whether this migration is sufficiently significant to allow a demarcation of different weight bearing types will be investigated during the continuation of the work

It is also possible to make similar measurements even under the fore part of the foot s weight bearing surface

The purpose is to get a technically simple measuring apparatus for

objective registration of the foot's weight bearing on standing and walking in shoes

RESUME

Une nouvelle methode a ete conçue pour enregistrer le poids dyna mique et statique porte par le pied dans le soulier Le composant verti cal de la charge est mesuré dans la region du talon A cet usage on utilise un balancier flexible raide dans lequel la deflection est enregi stree par strain gauges La resolution de la charge du poids porte qui correspond au point d action de la charge sur la surface portante oscille sur cette surface d une maniere caracteristique pendant la phase qui s ecoule pour faire un pas

On etudiera dans des travaux ulterieurs si cette oscillation a une signification suffisante pour permettre une demarcation des differents types de poids porté

Il est aussi possible d effectuer des mesures similaires sous la partie anterieure de la surface du pied portant le poids

Le but est d arriver à construire un appareil de mesure tres simple pouvant enregistrer objectivement le poids supporte par le pied dans le soulier pendant l arret ou la marche

ZUSAMMENFASSUNG

Eine neue Methode zur Messung der dynamischen und statischen Belastung des Fusses im Shuh ist entwickelt worden Die vertikale Komponente der Belastung wird im Bereich der Ferse gemessen Zu diesem Zwecke verwendet man eine steife Federwage in welcher die Federung mittels Dehnungsmesstreifen registriert wird

Die Resultante des Belastungsdruckes die dem Angriffspunkt der Belastung auf der Unterlage entspricht wandert wahrend der Be lastungsphase eines Schrittes in charakteristischer Weise uber die Be lastungsflache Ob diese Wanderung hinreichend signifikant ist um eine Abgrenzung von verschiedenen Belastungsformen zu erlauben wird in einer folgenden Arbeit untersucht werden

Es besteht die Moglichkeit entsprechende Messungen auch unter den vorderen Stutzpunkten des Fusses vorzunehmen

Die Absicht ist einen technisch einfachen Apparat zur objektiven Messung der Belastung des Fusses beim Gehen und Stehen im Schuh zu erhalten

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FROM THE ORTHOPAEDIC CLINIC, HÄRNÖSAND
CHIEF SURGEON: DR. NILS LINDSTRÖM

MELORHEOSTOSIS

Report of a case

By

LARS UNANDER SCHARIN, M.D.

A man aged 49 is the subject, a woodsman and manual worker who ever since his childhood has been troubled by a certain stiffness and feeling of tiredness in his left knee and his left foot. He has also experienced a longish period with a difficult eczema. After 1941 he was examined on several occasions at the orthopeadic department in Härnösand and he complained about aching and stiffness in his left knee joint and foot. At several examinations limitation of movement in the knee joint and some thickening of the capsule could be established. On 10.10.57 a follow up was instituted and it proved that mobility in the left knee joint had considerably lessened and at the same time the pain had increased. It was difficult for him to carry out his work. The range of movement in the knee was 150°–90°. X-ray examination showed significant progress of the strata typical of melorheostosis. These had as it were slipped down in the joint cavity so that exostosis formation was present (see fig. 1). On the inner aspect of the foot and lower leg a projection was palpated and there was moderate pain on pro- and supination movement in the tarsus. Radiology showed typical changes here too (see fig. 2). As regards the increasing trouble from the left knee operation was proposed. This took place 18.10.57. Medial incision. The capsule was considerably thickened, greyish white and hardened with strong fibrosis. At the back of the medial femoral condyle a large mushroom like exostosis was found and a similar smaller one in the anterior part of the condyle plainly projecting from the changes here too (see fig. 2). As regards the increasing trouble from away, after which the knee could be extended, but 10° extension defect remained in spite of this. At the follow up the patient reported considerable improvement and he was capable of returning to his work



Fig 1

Here a case of melorheostosis is involved a very rare complaint which was described for the first time by *Leri & Joanny* 1922 In the typical cases the changes are localized to one of the extremities The contour of the affected leg is sooner or later distorted The name was suggested by *Leri & Joanny* It was their opinion that the change resembled half liquid wax hence the name *Putti* published in 1927 two cases both localized to the lower extremities He gave the change the name of osteosi eburnizzante monomelica Further cases were published by *Ljunghagen* 1930 *Wakeley* 1931 *Boggon* 1938 *Franklin & Matheson* 1942 *Fairbank* 1948 *Thompson Allen Andrews* & Gillwald 1951 and *Campbell* 1955

The etiology is unknown *Putti* suggested that the cause is ischemia secondary to local changes in the sympathetic nerve system

The disease is more common in men but also occurs in women and cases have been described from the age of 5 to 50 it is probable however that the condition arises in childhood and possibly even prior to birth (*Ljunghagen* 1930)



Fig. 2

Localization: the upper extremities are less affected than the lower and it is typical that the changes are mostly localized to one extremity. Fairbanks states that he found 7 cases in the literature where the localization occurred in more than one extremity.

The pain is the most characteristic feature. It is aching and continuous, often quite severe. *The limitation* of movement was plain in half of the cases (*Fairbank* 1948). The cause of this limitation of movement is, as in the case described, often exostosis formation but in addition the affection of the joint capsules. A change in the configuration of the extremities occurs often with oedema, but deformities of the type genu valgum or varum seldom arise. Scleroderma with fibrosis and thickening of muscles and other tissues have been described in a number of cases (*Thompson, Allen, Andrews & Gillwald* 1951). The present case also experienced over a period a very troublesome eczema which may well have been just such a change in the soft tissue.



Fig 3

Radiological changes in typical cases sclerotic featureless strata of the type "marblebones" are found The previous description of liquid wax characterizes the radiological picture One gains the impression that these strata follow the vessel and nerve paths In the epiphyses and in the short bones e g in the foot or hand the strata alter their character and resemble spots streaks or blurs It is characteristic that

ertain progress occurs but it is very slow Such was the condition in e case described

The pathological picture is very specific and shows a strangely tterned picture with lamellae in irregular constructions A mixture mature and immature bone is found

The diagnosis in typical cases is easy As against general osteope osis the disease is distinguished by its localization usually to one tremity In these cases therefore the whole skeleton should always X rayed The differential diagnosis from osteopetrosis is normally sy The latter disease is a general affection of the skeleton and is t bound to one extremity as melorheostosis often is

SUMMARY

Melorheostosis is a rare disease which is mainly localized to one tremity of the skeleton usually in the lower extremities It is char terized by pain and limitation of movement which is often very oublesome in advanced cases Presumably the disease begins prior birth or in early childhood and progresses very slowly In the case escribed above the changes were localized to the left knee joint where ere gradually occurred a considerable limitation of movement which ould partly be remedied by chiselling away the protruding bone strata he diagnosis is typical The radiological picture has been compared to quid drops of wax which as it were run down the long bones and are calized along the vessel and nerve paths In the small bones the anges are of somewhat different character and resemble ink blots r are streaky

RESUME

La mélorheostose est une maladie rare localisee essentiellement dans s os des extrémites habituellement des extremités inferieures Elle e caracterise par des douleurs et une limitation de la mobilite souvent onsidérable dans les cas avances Il est probable que la maladie ap-arait deja au cours de la vie fetale ou tres tot dans les annees de enfance et qu elle progresse très lentement Dans le cas décrit ci essus les modifications sont localisées au genou gauche dans lequel l est peu a peu apparu une limitation notable de la mobilite qui peut ependant etre partiellement supprimée par le grattage de la produ sseuse anormale Le diagnostic est typique La radiographie

quelque chose qui ressemble a des gouttes de cire liquide qui paraissent couler dans le canal des os longs et sont localisees sur les vaisseaux et les filets nerveux Sur les petits os les modifications ont un caractere a peu pres analogue et ressemblent a des patés d encre ou a de petites taches

ZUSAMMENFASSUNG

Die Melorheostose ist ein seltenes Leiden das sich wesentlich im Skelett einer Extremitet gewöhnlich in den unteren Extremiteten lokalisiert Sie ist durch Schmerzen und Bewegungseinschränkung charakterisiert die in fortgeschrittenen Fällen oft sehr beschwerlich sind Wahrscheinlich tritt die Anlage zur Erkrankung bereits beim Fötus oder im frühzeitigen Kindesalter auf und schreitet sehr langsam fort In dem oben beschriebenen Falle sind die Veränderungen am linken Kniegelenk lokalisiert wo nach und nach eine bedeutende Bewegungseinschränkung auftrat welche doch teilweise mittels Abmeislung der hervorstehenden Knochenauflagerungen behoben werden kann Die Diagnose ist charakteristisch Das rontgenologische Bild wurde mit Wachstropfen verglichen die sozusagen entlang den langen Röhrenknochen fliessen und an den Gefäss und Nervensträngen lokalisiert sind An den kleinen Knochen zeigen die Veränderungen ein etwas verschiedenes Aussehen und gleichen Tintenklecksen oder kleine Striche

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FROM THE ORTHOPAEDIC DEPARTMENT OF THE KAROLINSKA INSTITUTET STOCKHOLM (HEAD PROF S FRIBERG)

A FOLLOW UP STUDY OF OSTEOGENIC SARCOMA

By

S CEDERLOF T HIERTONN and E SALÉN
Stockholm

The progressive increase in the knowledge of the pathology and biology of bone tumors during recent years has given rise not only to certain changes in the anatomical and pathological classification but also to new conceptions regarding their treatment and prognosis This concerns even the osteogenic sarcomas The five year survival figures in the literature vary between 5 and 30 % (*Jaffe* 1958) Figures from the orthopaedic clinics here in Sweden are not so far available

In the orthopaedic clinic of the Karolinska Institutet due in part to collaboration with Radiumhemmet a relatively large and uniformly assessed material of bone tumors is gathered which we have followed and analysed with great interest This article will throw light on the prognosis in our material of osteogenic sarcoma and in this connection the proposed treatment method of Sir Stanford Cade will be discussed

DEFINITIONS

We mean by the term osteogenic sarcoma or osteosarcoma those primary malignant tumors of bone which apparently have their origin from osteoblasts and abnormal and malignant bone and osteoid are formed as tumor components Since the precusor cell is totipotential osteosarcomata may contain fibroblastic components and malignant cartilage in addition to bone and osteoid Depending on the predominant differentiation observed microscopically in sections taken from various parts of the tumors they may be classified as osteoblastic chondroblastic or fibroblastic With few exceptions it is possible to make a clear cut differentiation between chondro or fibroblastic osteogenic sarcoma on the one hand and chondro or fibrosarcoma on the other hand the latter two are not included in this investigation

MATERIAL

The material consists of 41 proven cases of osteogenic sarcoma from the orthopaedic clinic during the twenty year period 1940–April 1959 and treated surgically either by amputation or disarticulation. In a little more than one half of the cases the operation was performed in the clinic with or without preoperative radiation therapy and in the remaining cases the operation was performed elsewhere and the patients were referred to us for prosthesis training and rehabilitation.

We would like to express our gratitude to Professor L. Santesson and his associates for their assistance in this study and we are particularly indebted to Dr. H. Spjut from Barnes Hospital, St. Louis, U.S.A. for critically reviewing the microscopic sections from our patients during his time at the Radiopathological institute in Stockholm in 1960.

Age and sex distribution

The average age for osteogenic sarcoma is lower than for such related tumors as chondrosarcoma and fibrosarcoma as shown in table I.

TABLE 1

	Number	Males / fem.	Age distribution	Average age
Osteogenic sarcoma	41	24/17	7¹–76 years	20
Chondrosarcoma	10	5/5	23–70 years	43
Fibrosarcoma	7	3/4	30–62 years	48

The ages are taken from the time when symptoms of the tumor first developed. With regard to the ages the material is homogeneous. Only one patient is remarkably older than the others (see fig. 1). 32 patients (78 %) are aged 20 or younger. The number of males is 60 %.

Location

The distribution of the osteosarcomata according to site of involvement is indicated in fig. 2.

34 (83 %) of the osteosarcomata were in the vicinity of the knee and 3 of the remaining 7 were in the proximal end of the humerus.

As shown in fig. 2 there are only 2 cases in this series in which the osteosarcoma is situated outside the long bones, namely one in the scapula and one in the big toe, and these two patients were the only ones that exceeded 40 years of age (41 and 76 years respectively).

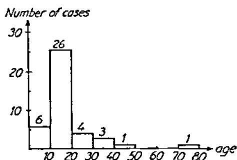


Fig 1
Age distribution of patients with osteogenic sarcoma

Chondrosarcoma
Fibrosarcoma
Osteosarcoma

Chondrosarcoma	Fibrosarcoma	Osteosarcoma
	1	1
2	1	3
	1	
1		1
2		
1		1
1		17
3	3	15
	1	2
		1
10	7	41

Fig 2
Anatomical distributi n of 1 ne arc m t

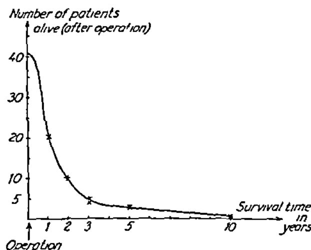


Fig 3
Survival time after operation for osteogenic sarcoma

Survival rates

The length of survival is computed from the date of the operation The five year survival rate is based on 27 patients treated before April 1955 and the ten year group consists of ten cases treated before April 1950

There were *only 3 patients* who *survived 5 years* (11 %) (One of these succumbed with pulmonary metastases 6 years and 9 months after an above-knee amputation for osteosarcoma in the end of the tibia)

Only *1 patient out of 10 is still alive 10 years* after operation

In the whole series of 41 cases of osteosarcoma 20 died in less than 12 months after operation Another 11 patients succumbed between 12 and 24 months after surgery while the remaining 10 cases (24 %) survived more than 2 years The diagram in fig 3 shows the survival at different periods of time

The relation of the survival rate to the position of the tumor and the promptness of operation

One might think that immediate ablation of the affected limb would be the best and most uncontroversial course of action In the present material however the patients with a longer interval between the onset of symptoms and operation apparently have a somewhat longer survival

time than those with less delay before operation (table 2) but the significance is not certain

TABLE 2

Postoperative survival time	Number of cases	Average interval between onset of symptoms and operation
<12 months	20	3.8 months
>12—<24 months	11	4.7 months
>24 months	10	6.8 months

It is a prevalent opinion that the prognosis is more favourable when the tumor is in the tibia than in the femur Out of the 4 patients who survived more than three years the site was in the tibia in 3 and in the distal end of the femur in 1

The significance of preoperative radiotherapy can not be assessed in this material It is possibly worth mentioning that the only patient who lived more than 10 years was the only one who received a preoperative *radiation dose which could be called large (more than 9000* r during three months)

The relation of the survival rate to the microscopic appearance

The microscopic differentiation of tumors has a certain significance in the prognosis Without doubt the most common type of osteosarcoma is the osteoblastic Only three cases of this type were found among the ten patients who survived more than two years while six belonged to the chondroblastic and one to the fibroblastic variety

Three out of the six cases of chondroblastic osteosarcoma were in the tibia and the others were in a big toe humerus and femur respectively The fibroblastic osteosarcoma was in the distal end of the femur That *is independent of their position the chondroblastic and fibroblastic* osteogenic sarcomata apparently have a somewhat better prognosis than the osteoblastic type and this is the opinion held by most authors on the subject

DISCUSSION

Our material is highly selected The tumor site in all cases except one in the scapula was in the extremities and thus there are no tumors in the more inoperable central positions Some of the patients had

their operations in other hospitals and not until some months later were they admitted to this clinic for rehabilitation and in this way some of the most urgent cases never lived to come here Despite these favourable factors the five year survival is discouragingly low (11 %)

This series of 41 cases is small but it is more homogeneous than others published on the subject 85 % of the patients are under 25 years of age All but one have pure osteosarcoma in the extremities (see fig 2) Operation was performed early The interval from onset of symptoms to surgery was less than 12 months in 39 cases The other two were amputated 14 and 18 months respectively after the onset of symptoms

The value of early mutilating surgery must be considered as small in view of the fact that 50 % of the patients will die from metastases in less than one year after operation It seems tempting therefore to advocate the treatment as proposed by *Cade*, of deferring amputation or disarticulation until sometime after the lesion has been treated by heavy irradiation In this way the most fulminating cases will be spared unnecessary ablative surgery The definitive results of this therapeutic regime have not yet been published by *Cade* but it appears from his preliminary report that the prognosis is better than after amputation at an early stage It is not yet clear whether the reason for this improved prognosis depends on the intensive radiation therapy or on surgical treatment being reserved for the biologically least malignant tumors

Considering the depressing survival figures resulting from the scheme of treatment we have employed up to now—one half dead within a year after operation only 3 of 27 living after 5 years and only 1 living out of 10 after 10 years —it is natural that we together with colleagues from Radiumhemmet have begun to study and to apply the new therapeutic approach

The principles of the new treatment are carried out in the following way Confirmation of the diagnosis by open biopsy radiation by the supervoltage X ray machine (6000–8000 r) during a period of 30–40 days expectancy for 6 months thereafter and if metastases have not appeared high amputation of disarticulation

To assure that the patients with bone tumors get the benefit of expert opinions from as many quarters as necessary (tumor biology tumor pathology radiotherapy roentgenography and orthopaedics) we have for several years carefully aired these cases at clinical pathological conferences The difficulty of the problem and the relative rarity of malignant tumors of bone make desirable a certain centralization

of bone tumor cases to clinics possessing the necessary facilities. This centralization also benefits pre- and post-graduate teaching. The Swedish bone tumor registry (*Lindbom & Santesson* 1957) is greeted with satisfaction.

SUMMARY

A total of 41 cases of osteogenic sarcoma, considered from the anatomical and pathological viewpoints, and operated by amputation or disarticulation (with or without pre-operative radiation) from 1940–April 1959 inclusive, have been studied. Twenty died within one year, and a further 11 died during the second year. 10 cases (24 %) survived more than 2 years. The five-year survival rate based on 27 cases operated prior to April 1955 amounted to 3 (11 %). Only one patient operated before April 1950 is living now!

The value of early amputation is questionable. The plan of therapy proposed by Sir *Stanford Cade* with intensive pre-operative radiotherapy and delay of amputation for 6 months is discussed. A certain centralization of bone tumor cases is desirable.

RESUME

41 cas de sarcome osteogenetique operes par amputation ou disarticulation (avec ou sans radiation pre-operatoire) entre 1940 et avril 1959 inclus ont ete etudies en partant de considerations anatomiques et pathologiques. Vingt des malades sont morts dans l'espace de la premiere annee et 11 dans l'espace de la deuxieme annee. 10 cas (24 %) ont survecu plus de 2 ans. Le taux de survivance de plus de cinq ans a été calculé sur la base de 27 cas operes avant avril 1955. Il s'eleve a 11 % (3 malades). Un seul des malades operes avant avril 1955 vit encore aujourd'hui.

La valeur de l'amputation precoce est douteuse. Discussion du plan de therapie proposé par Sir *Stanford Cade* avec radiotherapie pre-operatoire intense et un delai de 6 mois avant d'effectuer l'amputation.

Il serait souhaitable d'effectuer une certaine centralisation des cas de tumeur osseuse.

ZUSAMMENFASSUNG

Eine Gesamtzahl von 41 Fällen von osteogenetischen Sarkom, vom anatomischen und pathologischen Gesichtswinkel betrachtet, die mittels Amputation oder Exartikulation (mit oder ohne präoperative Be-

strahlung) von 1940–April 1959 behandelt wurden sind untersucht worden Zwanzig starben im Verlaufe eines Jahres und weitere 11 während des zweiten Jahres 10 Falle (24 %) uberlebten mehr als zwei Jahre Die Zahl der Überlebenden nach 5 Jahren war unter Zu grundelegung von 27 Fallen die vor April 1955 operiert worden waren drei (11 %) Nur ein einziger Patient von denen die vor April 1955 operiert worden waren lebt noch

Der Wert der fruhzeitigen Amputation ist zweifelhaft Der von Sir *Stanford Cade* vorgeschlagene Behandlungsplan der in einer inten siven praoperativen Rontgenbestrahlung und späterer Amputation nach 6 Monaten besteht wird besprochen

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FROM THE MEDICAL DEPARTMENT III SÖDERSJUKHUSET
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ON THE PROGNOSIS OF RHEUMATOID ARTHRITIS

By

ERIC JONSSON

Of all internal diseases rheumatoid arthritis certainly is one of the most difficult from the therapeutical point of view. Also the diagnosis can be rather intricate especially in early cases where the clinical picture varies considerably.

What can be said concerning the prognosis?

More and more we have become aware of the fact that we know very little of the natural course of the disease and of the factors which influence it. By the very nature of the material dealt with, human subjects, the course of the disease has rarely been studied in its natural state because aspirin can be obtained without prescription and is commonly used by patients long before they consult the physician (Ragan). Further studies of the course of rheumatoid arthritis are usually restricted to patients who come to a particular physician, clinic or hospital. Thus such groups of patients are to be considered as ill defined selections from the total number of individuals with rheumatoid arthritis in the general population (Reynolds, Short and Bauer).

It would appear, says Duthie, that about 50 per cent of the patients fare "reasonably well" regardless of the form of treatment used. In 15–25 per cent the prognosis is said to be "excellent". In the 50 per cent who do badly about 15 per cent become inactive with considerable residual disability and 10 per cent become "severely crippled". Of course Duthie's figures are to be considered approximate. Only a few long term studies have been conducted.

The choice of criteria for assessing the course of the disease has been much discussed. Clinical and laboratory observations are usually divided into two categories: a) those which are thought to reflect the degree of activity of the disease, e.g. signs of joint inflammation, sedi-

mentation rate etc and b those which indicate the functional capacity of the patient e g range of joint motion strength of grip and so forth Although changes in these two categories are often related it seems desirable to maintain the distinction (Reynolds Short and Bauer) Data from one or both categories have been used to measure remission or exacerbation in the course of the disease but too little is known about the reproducibility of such measurements in term of observer errors

As for laboratory findings we know that the sedimentation rate the acute phase protein etc often run parallel with the activity of the disease Determination of serum glycoproteins has also been widely used in evaluating activity changes Previously the sialic acid content of serum (measured by very unspecific colorimetric methods!) has been the usual test Shetlar and coworkers have recommended determination of seromucoid according to Winzler (= perchloric acid soluble glycoprotein fraction) This heterogenous fraction has been specially studied at the South Hospital by Nettelbladt and Sundblad — We do not know much about the relationship between the activity of the rheumatoid process and titer of the rheumatoid factor — In all clinical studies outside the laboratory we should not forget 2 important factors which are often overlooked the patients psychic reactions and the examiner s personality !

In order to obtain a suitable material for our prognostic studies we first of all should decide what is meant by rheumatoid arthritis Unfortunately there is a wide difference of opinion as regards this matter even if we exclude all cases of juvenile arthritis psoriatic arthropathy arthritis in ulcerative colitis rheumatoid cases with L E cells agam ma globulinemia cases and—of course !—ankylosing spondylitis

If too rigid diagnostic criteria are employed whereby only typical far advanced cases are included we will get another impression of the course and prognosis of the disease than if we adopt more liberal criteria whereby atypical early and less severe cases are included in the material to be examined (Ragan) Unfortunately we have not had as yet so much benefit from the sheep cell agglutination and other such tests for practical diagnostic purposes in early cases

Kellgren et al Cobb et al and Lawrence and Bennet point out that although rheumatoid arthritis is commonly thought of as a severe and crippling disease many individuals suffer from minor forms of the rheumatoid process which give rise to only minor degrees of disability

Even the best diagnostic criteria therefore are insufficient Cobb having given a survey of the work of the Criteria Committee of the American Rheumatism Association exclaims It came as a bit of a shock to the Committee to discover that 30 per cent of cases that might be called definite rheumatoid arthritis by one or another physician did not meet the set of criteria that the Committee was able to establish There remained cases that most physicians would consider definite rheumatoid arthritis which did not meet the criteria and similarly there were cases that met the criteria but which would not be considered to be definite rheumatoid arthritis by most astute clinicians

One and the same doctor should follow the cases all the time i e for a *very* long time A material where one doctor has examined the cases at their onset and another doctor five or ten years later is of very limited value

Data obtained in whole or in part from retrospective searches of clinical records are especially suspect yet much of our present knowledge of the course of rheumatoid arthritis depends upon information obtained in this way (Reynolds Short and Bauer)

Another difficulty ought to be touched upon The onset of *articular* symptoms does not mark the onset of the disease process in a case of rheumatoid arthritis Prodromal symptoms are often observed (general weakness low grade fever emotional symptoms loss of weight etc) But can we be sure that even these prodromal symptoms denote the beginning of the disease process? Certainly not because the rheumatoid panmesenchymal process may have been going on for a long time without giving any clinical symptoms at all Thus we find that in fact it is impossible to establish at what time the disease process really started in a case of rheumatoid arthritis

Often the patient has had a period with atypical joint symptoms long before the appearance of a manifest rheumatoid arthritis (The patients should be thoroughly interrogated about this as they cannot very well remember slight symptoms years ago and seemingly without any connection with their actual disease!) If such cases are included in a clinical material the result of prognosis studies will be quite different according to which phase of the disease the examination and the evaluation is made

Thus in studies of the prognosis of rheumatoid arthritis one must arrive at different conclusions depending upon which material one is working with easy cases severe cases cases with a long or a short duration and so forth Indeed it seems rather debatable if such a var

able condition as rheumatoid arthritis really constitutes one single and unitary disease! Anyhow it seems advisable in prognostic studies to separate the patients into groups with features that have a clearly established and strong relationship to the course of the disease and which should be very likely to react to a markedly different degree from each other (Calkins et al.)

We had better refrain from intricate and subtle statistical methods the primary material i e the clinical data often being very diffuse The basis for subdivision of the cases should be as simple and unsophisticated as possible age sex type of onset and the like In this way a few types can be discerned

1 *Cases with insidious onset* are thought to have a more unfavorable prognosis—just as cases with a persistently high sedimentation rate marked muscular atrophy abundant subcutaneous nodules etc

Symmetry of the joint symptoms may also involve an unfavorable prognosis The present author observed a type of rheumatoid arthritis that displayed pronounced asymmetrical articular symptoms and seemingly had a very slight tendency to progress However after having followed these cases for a long time I am no longer inclined to believe the prognosis so favorable as I had anticipated a fact which clearly illustrates the importance of a very long time of observation in rheumatoid arthritis cases

2 Probably the prognosis is *better in males* than it is in females An illustrative example

♂ born in 1904 2191/55 Rheumatoid arthritis with symptoms first in one wrist later in most joints Sedimentation rate 55 mm Temperature normal Gold treatment After 2 months much better post or propter Sedimentation rate 1 mm A slight exudate persisted in the left knee for some time but disappeared after 6 months The patient was later free from symptoms and now feels perfectly well A slight atrophy of the left quadriceps muscle persists The sedimentation rate is still normal

In this case the prognosis may be favorable But in all prognostic studies in rheumatoid arthritis it is important to remember that remissions are often seen especially in early cases and that they can be of a long duration (See below Fig 2)

3 *Cases with an acute onset* may subside rapidly and may have a better outlook than those with an insidious onset

♀ born in 1927 13451 57 —Very acute onset in August 1957 with high fever (40) severe joint symptoms especially in her shoulder

joints and sedimentation rate 160 mm Electrophoresis very pathological Albumin 38 α1 5 α2 16 β15 γ26 % = decreased albumin value and increased α and γ Neisseria complement tests negative

After a few months the articular symptoms subsided and disappeared The sedimentation rate and the electrophoresis curve became normal

The patient is still in excellent health

♂ born in 1905 20380 58 Very acute onset 1958 with joint effusions and high fever (39 5) Sedimentation reaction 156 mm Electrophoresis α1 10 α2 18 β17 γ20 Total protein 3 5—Electrophoresis curve of a type which is encountered in nephrosis[1] Neisser complement tests were negative

In this case too the symptoms subsided post or propter gold treatment The patient is still in excellent health and his sedimentation reaction is normal

Certainly these two cases must be supervised for many years as the ultimate prognosis is still uncertain and an exacerbation may supervene Unfortunately we are quite unable to establish if the disease *process in a case of rheumatoid arthritis is healed or not The expression* "burnt out case is very unsuitable and should not be used'

4 Evidently the prognosis in juvenile arthritis is better than in adult rheumatoid arthritis (Ansell and Bywaters Edstrom et al) As for adults Duthie et al think that age at onset of the disease is of no great significance and apparently Short Bauer and Reynolds are of the same opinion

However a correlation between age at onset of the disease and prognosis seems to exist for adult cases too At the South Hospital and over a long period several cases have been observed (E Jonsson and A Wesslau) who started in the early youth and have done remarkably well

♀ born in 1913 26355 44 Rheumatoid arthritis since 1931 when she was 18 years *old Very long remissions X ray small but distinct* articular erosions Sedimentation rate always elevated at present 80 mm The patient s subjective symptoms are mostly slight and her exacerbations as a rule of short duration No anemia

In some of these cases the radiological changes are very severe although the subjective symptoms are very slight Fig 1 shows the x ray picure from such a case The patient born in 1918 has had rheumatoid arthritis since she was about 15 years In spite of the extensive destructions in her right foot she can walk very well and she has



Fig 1

♀ born in 1918 "Adolescent case" Extensive radiological changes Severe destruction in the basal interphalangeal joint I and extreme atrophic changes in the V meta carpal bone (arthropathia mutilans) Only slight subjective symtoms

worked as a head waitress at a restaurant Sedimentation reaction 36 mm No anemia

Apparently the inflammatory reaction is milder in these adolescent cases

The rheumatoid arthritis thus runs a long course often with erratic exacerbations and remissions Can we by means of *therapeutic measures* influence the prognosis?

Without more exact information on the natural history of the disease it will be impossible to answer this question and to assess the value of our therapeutic methods And here we are touching on the same problems as before i e the imprecision in our present day diagnostic methods the difficulty in recording the course of the disease in measuring the disease activity and so on And unfortunately it is impossible to obtain an adequate control material for therapeutical research

As Ragan points out it is also difficult to make an adequate assessment of the end result The intensity of the disease waxes and wanes and every evaluation must be classed by the day the evaluation was made

Ragan suggests the use of the term management rather than cure or treatment We have come to realize that we cure very few!

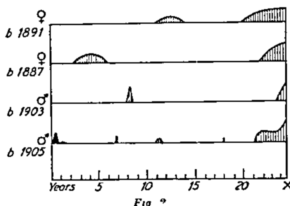


Fig 2

The course in 4 cases of rheumatoid arthritis

▲ = acute episodes ||||| = chronic symptoms Diagnosis settled at X

Discoveries of potent and wondrous remedies for rheumatoid arthritis are not made as frequently nowadays as formerly and healing is not claimed as in older times More criticism but also more pessimism has succeeded the former naive optimistic attitude when enthusiastic therapeuts achieved good results in the inevitable 75 % of all cases of rheumatoid arthritis without suspecting that they were only watching the natural course of the disease In Fig 2 the course of 4 cases is accounted for graphically It appears from the figure that without acquaintance with the tendency for remissions of this annoying disease wrong conclusions could easily be drawn about the efficacy of a remedy given in one of these cases shortly before such a remission

Certainly we had better fairly admit that we—as in most other internal diseases'—do not dispose of any potent therapeutical method in rheumatoid arthritis (possibly with the exception of gold treatment in early cases?) and that "optimal methods of therapeutical evaluation must await further knowledge concerning the nature epidemiology course and pathogenesis of the disease (Calkins et al) The surgery of rheumatoid arthritis presents a "peculiar problem because of the "difficulty of foretelling with any accuracy the subsequent course of the disease (Bastow)

SUMMARY

The prognosis in some types of rheumatoid arthritis is discussed and therapeutical questions are touched upon

In fact we know very little of the natural course of this disease and

only a few long term studies have been made —Present day diagnostic methods are imprecise and the diagnostic criteria are insufficient Because of this and because of the difficulty in recording the course of the disease research work on its prognosis constitutes a very delicate problem

RESUME

Le pronostic des differents types d arthrite rhumatoide est discute et les questions therapeutiques sont abordees

En fait nous savons tres peu de chose sur le cours normal de ces maladies et tres peu d études a long terme ont ete effectuees Les methodes actuelles de diagnostic sont imprecises et les criteres du diagnostic insuffisants Pour cette raison et a cause de la difficulte qu il y a a enregistrer le cours de ces maladies les travaux de recherche sur leur pronostic constituent un probleme tres delicat

ZUSAMMENFASSUNG

Die Prognose einiger Arten von chronischem Gelenksrheumatismus wird besprochen und Fragen der Behandlung werden beruhrt

Wir wissen tatsächlich sehr wenig uber den Verlauf der Krankheit und nur wenige Untersuchungen uber einen langen Zeitraum sind ausgefuhrt worden – Die heutigen diagnostischen Methoden sind ungenau und die diagnostischen Richtlinien sind ungenügend Deshalb und auch wegen der Schwierigkeit den Verlauf der Erkrankung aufzuzeichnen stellt die Forschungsarbeit hinsichtlich der Prognose ein sehr schwieriges Problem dar

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FROM THE ORTHOPAEDIC CLINIC KAROLINSKA INSTITUTET STOCKHOLM
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LATE RESULTS OF KROGIUSPLASTY

By

STEN KARLHOLM

In recurrent patellar luxations the Krogius method has been employed as a routine operation at the Orthopaedic Clinic in Stockholm since the 30 s In 1947 Fellander carried out an investigation in which it proved to have satisfactory results When at a later period other methods were recommended in the literature it was considered that there were good grounds for continuing with an investigation of those cases which were operated even during the last 10 year period In these years 35 patients were operated on 4 of these bilaterally In the investigation I was able to reach 31 patients and amongst these were the 4 operated on bilaterally The observation period varies between 10 and ½ years on average 5½ years The age of patients at operation varied between 6 and 41 years The majority were however as usual in their twenties

In all cases but one the Krogiusplasty was performed with a double-stalked flap—thus this is firmly attached at both ends In 5 cases the plasty was combined with medial displacement of the tuberosity of the tibia Postoperatively the patient was treated with knee plaster on average for 2½ weeks The period in hospital lasted on average 5 weeks

At the follow up examination in 1958 31 knee joints were found with good functional status and in 4 cases there was recurrence

In the 31 cases free from recurrence there was complete mobility and good power in the quadriceps 8 cases had moderate atrophy of the quadriceps with an area of 1 cm (calculated 15 cm above the patella) 8 cases revealed signs of chondromalacia objectively with abundant crepitation and tenderness around the border of the patella and with more or less pronounced subjective trouble

A clear valgus position i e more than 15° was only established in 3 cases 1 of which at the follow up showed recurrence of luxation In

these 3 cases the Krogiusplasty had been combined with medial displacement of the tibial tuberosity.

In the recurrence cases this first arose in a woman aged 19 at operation with habitual congenital patellar luxation and considerable valgus position of the knees. Krogiusplasty was performed combined with displacement of the tuberosity. The patient suffered recurrence very soon postoperatively. Now she has much discomfort, cannot cycle, dance or take part in sport etc. The axial X-ray of the femoro-patellar joint showed considerable dysplasia.

The second case was a woman aged 20 at operation, who had had closely recurrent dislocations in the left knee since the age of 8½. She was operated on in 1939, 1940, 1942 with capsulorrhaplasy —

In 1948 the Krogius operation was performed at the Norrbackainstitutet with displacement of the tibial tuberosity 2 cm medially. 7 years after the operation the patient had habitual medial dislocations of the patella which gave however moderate trouble and have not occasioned any further operative measure. The patient is said to have had polio when aged 1 and has had since then an obviously weaker quadriceps in the leg operated on. A complete smoothing out of the condyle part is to be found on the X-ray without any danger.

In the 3rd recurrence case patellar exstirpation was performed owing to chondromalacia and habitual dislocations post-operatively.

During a traffic accident the patient happened to suffer a severe trauma at the age of 40 in 1948 and afterwards had habitual partial dislocations in the right knee. Krogiusplasty was carried out in 1948 without improvement of the condition. She was reoperated on in 1949 at NBI and recovered in 5 years. Afterwards habitual subluxations and increasing chondromalacia reoccurred and this brought about patellar exstirpation in February 1958.

In the 4th case of recurrence the patient, a woman aged 35 at operation, had habitual subluxations bilaterally and also complete dislocations. She had had trouble for 15 years. After operation the habitual subluxations remained on both sides but she is now fully free from the complete dislocations.

On radiological examination by axial pictures 29 dysplastic joints were found and 6 normal femoro-patellar joints. Amongst the 6 patients who had normal joints radiologically 4 had been exposed to severe trauma which started the dislocations. These were football and gymnastic injuries.

Those who had the most advanced anatomic changes experienced

their dislocations in early childhood With more moderate dysplastic changes the dislocations often began during the school years often spontaneously but sometimes initiated by a moderate trauma

As far as the mobility of the knee is concerned 8½ weeks on average intervened before the patient again obtained a flexion of 90 Those who most rapidly obtained full knee mobility again were the traumatic dislocations with normal femoro patellar joints These took 2 to 3 weeks

It proved that those patients who at the follow up showed signs of chondromalacia found it difficult in nearly all cases to regain knee mobility In 8 cases of clinical established chondromalacia at the follow up 14 weeks were required on average to obtain 90 of mobility in the knee This group does not consist of old patients the average age at operation was 25 years It appears possible that too great tightness of the capsule flap contributed to the development of chondromalacia Moreover the surgical report provides instances of this in a number of cases where the surgeon talks about considerable tightness Among other technical operative details it may be pointed out that all but one were operated with a double stalked flap In order to avoid too great tightness it is necessary to proceed into the vastus medialis which is freed and the muscle mass of which will lie across the quadriceps tendon when the plasty is complete Here it ought also to be attached to the extension apparatus so that it should remain in place When the plasty is finished one should be able to bend the knee to 80 –90 without too much tightness

In 1957 Gylling & Hellstrom made a post investigation into 21 operated cases The operation was performed according to Roux with displacement of the tuberosity medially distally this being with a screw The observation period averaged 5 years Increasing crepitation was found after the operation arguing that the method often provoked degenerative changes in the cartilage No recurrence of total dislocation arose but in ⅓ of the cases the patella remained subluxated In 14 cases the patients experienced discomfort from tenderness above the tuberosity post operatively and in 4 cases so much trouble that it was doubtful whether any improvement had been achieved

The Krogiusplasty has thus proved to be a good operative procedure and there are no grounds for abandoning it The Krogius method involves probably less risk of chondromalacia post operatively than for example the operation according to Roux

Follow up Examination Into Krogiusplasty 1958

31 patients including 4 Bilat. Total 35 Kneejoints
Observation period on average $5\frac{1}{2}$ years
3 recurrent

X-ray } Axial }	Dysplastic joints	29
	Normal joints	6

90° knee mobility was achieved after $8\frac{1}{2}$ weeks on average
In 8 cases of chondromalacia 90° mobility after 14 weeks

SUMMARY

A follow up examination was made into 35 knee joints with recurrent patellar dislocation operated according to a method which Krogius described in 1904.

At the examination 31 knee joints were found with good functional status and in 4 cases recurrence had set in.

In those cases in which chondromalacia was established post-operatively it had taken a particularly long time to regain knee mobility.

To lessen the risk of post-operative chondromalacia the importance of not stretching the flap too much is emphasized. With the plasty completed one should be able to bend the knee almost 90°.

RÉSUMÉ

Un examen complémentaire a été effectué dans 35 cas d'articulation du genou avec luxation de la rotule récidivante opérées d'après une méthode décrite par Krogius en 1904.

A l'examen, on a trouvé 31 genoux dont l'état fonctionnel était bon et 4 dans lesquels il y avait eu récidive.

Dans les cas où une chondromalacie post-opératoire avait été constatée il s'est écoulé une très longue période avant que le genou ait repris sa mobilité.

Pour diminuer le risque de la chondromalacie post-opératoire il est souligné qu'il ne faut pas tendre trop fort le lambeau. L'opération terminée le genou doit pratiquement pouvoir être plié à un angle de 90°.

ZUSAMMENFASSUNG

Es wurde eine Nachuntersuchung von 35 Kniegelenken durchgeführt, die wegen recidivierender Patellarluxation gemäss einer von Krogius im Jahre 1904 beschriebenen Methode operiert worden waren.

Bei der Untersuchung fand man 31 Kniegelenke in gutem funktionellen Zustand wahrend 4 einen Ruckfall erlitten hatten

Bei den Fallen in denen man postoperativ eine Chondromalazie feststellte nahm es besonders lange Zeit die Kniebeweglichkeit wiederzu erhalten

Um die Gefahr der postoperativen Chondromalazia zu vermindern betont man die Wichtigkeit die Kapselplastik niemals allzustark anzu spannen Nach Abschluss der Plastik sollte man das Knie beinahe 90 beugen konnen

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FROM THE ORTHOPAEDIC DEPARTMENT UNIVERSITY OF UPPSALA SWEDEN
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INTERTROCHANTERIC OSTEOTOMIES IN OSTEOARTHRITIS OF THE HIP

By

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At the present time 25 years after its introduction in 1935 by McMurray intertrochanteric displacement osteotomy is widely regarded as a useful tool in the management of painful osteoarthritis of the hip joint It has come into general use in recent years and despite its long standing information about the late results of the method is scarce Major interest has centered around mechanical and technical aspects of the operation and the causes underlying the unmistakable immediate good results

TABLE 1
Osteoarthritis of the hip joint treated by various surgical methods

	Number of cases					
	Number operated	Included in follow-up	Satisfied with improvement No.	%	Doubtful	Unimproved
Obturator nerve resection	18	18	5	30	9	4
Adductor tenotomy	16	15	8	50	1	6
Osteotomy	19	17	13	80	3	1
Arthrodesis	9	6	5	8	1	0

During 1955 and 1956 a number of different operative procedures were performed in this clinic After a certain time had elapsed a questionnaire was sent out to the patients in an attempt to evaluate the effect of the different operations The answers are tabulated in Table 1 A longer period of follow up might conceivably change the incidence of

favourable results, but this would probably hardly imply an improvement of poor results. It is more likely that the number of favourable results would be reduced. The table shows that the most effective methods were arthrodesis and osteotomy.

On the basis of these observations we decided during the next few years to perform osteotomy in cases of osteoarthritis of the hip joint with so much pain on weight bearing that walking became severely impaired and with pains at night following exercise. All patients operated upon were unable to work. The operation was performed in 54 cases during the period from 1956–1959.

It has been claimed that the effect of the operation is not dependent on the degree of medial displacement of the distal fragment. Nevertheless, the literature contains attempts at interpreting freedom of pain as a function of changed mechanical conditions. Many authors also suggest the possibility of improved vascularization to account for good results. Neither theory is endorsed by factual evidence. In this presentation the type of fixation used has been chosen as the point of reference.

TABLE 2

Various types of fixation in displacement osteotomies
Complete relief of pain was obtained in 30 %

		Without osteosynth	Kiesel plate	Blount plate	McKee plate	Tupman plate
Number of operations	54	13	23	5	8	5
Complete relief of pain	18	4	7	2	3	2

The surgical exposure permits a variety of techniques. The following method has been found suitable. The incision is made from the anterior superior iliac spine to the upper end of the greater trochanter and continued along the femur. The tensor fasciae latae muscle is divided in the direction of its fibers, the fascia lengthwise, followed by a small transverse incision just below the greater trochanter. The vastus lateralis is detached from its posterior attachment on the femur, neither its vascular nor nervous supply being impaired. There is little bleeding. The exposure permits a good view of the subtrochanteric area from a lateral and ventral aspect including the anterior portion of the neck. It is possible to see exactly when the osteotomy is made how the distal end of the femur may be displaced and to check the adaptation of the cut surfaces. The osteotomy is made with the bone incision



Fig 1
Displacement osteotomy without internal fixation

parallel to the long axis of the neck This permits medial displacement with little need for bone resection while at the same time ensuring satisfactory contact between the bony surfaces

In 13 cases *osteotomy without internal fixation* was performed All patients were immobilized in a double hip spica for 3 weeks on an average followed by a short single leg spica for an additional 5 weeks The patients were allowed up in the cast after about 4 weeks Some weight bearing was permitted and mobilization of the knee joint encouraged In 9 cases the roentgenograms showed the presence of callus after two months In the remaining cases healing occurred after 3 months The degree of medial displacement varied A varus deviation developed in 4 cases In 3 cases thrombosis set in during the period of healing causing painful swelling of the operated limb In all cases the spontaneous pains at rest disappeared and pain on weight bearing was reduced The patients declared themselves satisfied with this result Complete relief of pain was achieved in only 4 cases Seven patients had to walk with a stick Mobility became in no case better than before the operation In the majority of cases the range of movement had de-


Fig 2
Osteotomy with Kessel plate fixation


Fig 3
Blount plate in situ

creased without the patients considering it a cause for complaint The over all impression is that although the subjective results of the operation were remarkably satisfactory it did not come up to expectations with regard to functional qualifications

Osteosynthesis with a Kessel plate was performed in 23 cases In 16 cases a plaster was applied after operation and worn for 2 months Seven patients were not immobilized The incidence of thrombosis was high in both groups Callus could be observed after 3 months in some cases slightly later Radiological evidence of healing was found after 2 months in only 2 cases The number of patients with complete relief of pain was 7 all of them belonging to the group immobilized in plaster Wound infection developed in one case while in another the osteotomy failed to heal Eleven patients were unable to walk without a stick As a rule mobility was less than before the operation These observations have led us to the conclusion that no advantage is to be gained from using the Kessel plate It may even cause delayed healing due to the extensive damage the nail plate causes to the cancellous bone The plate



Fig 4
McKee nail plate fixation



Fig 5
Internal fixation with a Tupman plat

does not offer sufficient stability to the osteotomy to replace plaster fixation

In agreement with the group in which no osteosyntheses were performed the patients claimed that the operation had given them relief of spontaneous pains and reduced pain on weight bearing

Osteosynthesis with Blount s plate was performed in) cases As the fixation achieved was hardly secure plaster was applied Thrombosis developed in 2 cases Roentgenologic evidence of callus was found 2 3 months after operation The method did not appear to hold any appreciable advantages over osteosynthesis with the Kessel plate even though the degree of damage to the bone tissue was less

The *McKee nail plate* was used in 8 cases The initial stability of the osteosynthesis was better than in either of the methods mentioned before but the degree of medial displacement was less In) cases no plaster fixation was applied Callus could be demonstrated in the roentgenogram after 3 months Weight bearing was allowed after 2–3 weeks regardless of whether plaster fixation had been u d or not Three pa

tients were entirely free of pain The majority had to use a stick The incidence of asymptomatic cases was consequently not particularly high in this group either

The *Tupman nail plate* was used in 5 cases up to December 1959 During 1960 it was the method of choice The 5 cases which permit evaluation give occasion for the following comments In no case was plaster fixation considered necessary The patient was allowed to leave his bed after 2–3 weeks while mobilization exercises of the knee and hip joint could be started one week following operation Callus could be observed after 2 months Three patients had to use a stick All patients were improved but only 2 were entirely free of pain Thrombosis did not occur

DISCUSSION

The principal reason for operative treatment of osteoarthritis of the hip joint is to provide relief of pain and secondly to preserve or improve mobility Viewed against this background the results of our osteotomies cannot be considered wholly favourable Unquestionably the pain is alleviated although it does not entirely disappear Spontaneous aching pain ceases however and the majority of patients note a subjective improvement The patient s activity on the other hand is hardly increased A great number are forced to use a stick The range of movement of the hip joint was often reduced seldom improved

Obviously the end results are considerably influenced by the selection of cases Many authors have held that an osteotomy should not be performed if mobility is already poor before the operation If this limitation is accepted better results will probably be obtained On the other hand the indications for surgery then become altogether relative

Several authors have claimed that osteotomy affects the pathologico anatomical process of osteo arthritis According to this theory a reconstruction takes place in which the head is revitalized and the joint space regains a more normal appearance No evidence of this has been seen in this material Sometimes the roentgenogram shows an increased joint space Pictures taken both during and immediately following the operation have clearly demonstrated that the position of the head in the acetabulum may lead to an erroneous interpretation of the joint space No basis for the belief that the pathological process is in any way altered was found The optimism with which osteotomy is regarded is undoubtedly exaggerated

Although osteotomy offers possibilities for correction of deformities

the effect of the operation is not always lasting Flexion and adduction contractures often recur even after the fragments have healed in the desired position

The conditions for healing are good and callus occurs after 2–3 months regardless of the technique used The Tupman nail plate recently introduced from England provides good internal fixation during healing and permits early mobilization Plaster fixation is unnecessary This implies fewer complications as mobility can be better preserved and the risk of thrombosis is reduced Moreover hospitalization time is cut down which means that the indications for operation may be extended to include even elderly patients

SUMMARY

Various types of internal fixation in displacement osteotomies for osteoarthritis of the hip are discussed Even if the number of cases with complete relief of pain amounts to only 30 % about 80 % claim that they are improved The mobility in the hip does not seem to increase and the radiographic appearance of the osteoarthritis does not change The advantage of safe internal fixation makes postoperative plaster fixation unnecessary Tupman plates were found very helpful Better care can then be taken of hip and knee joint mobility and the time of rehabilitation is shorter

RESUME

Différents types de fixation interne dans les osteotomies de déplacement pour les ostéoarthrites de la hanche sont discutés Bien que le nombre des cas completement soulages de douleurs ne se soit eleve qu a 30 % seulement 80 % pretendent qu ils sont sensiblement amelio res La mobilité de la hanche ne parait pas s accroitre et l apparence radiographique de l ostéoarthrite ne change pas L avantage d une fixation interne sure est qu elle rend superflue la fixation posteopera toire dans le platre *On a constate que les plaques Tupman sont utiles Il est plus facile de veiller a la mobilite de la hanche et du genou et le* temps de restauration est plus court

ZUSAMMENFASSUNG

Verschiedene Arten von innerer Fixierung bei Verschiebungsosteotomien in Fällen von Osteoarthritis des Huftgelenkes werden besprochen

Selbst wenn die Anzahl der Fälle mit vollständiger Beschwerdefreiheit nur 30 % beträgt geben doch ungefähr 80 % eine Besserung an Die Beweglichkeit der Hüfte scheint nicht zuzunehmen und das röntgenologische Aussehen der Osteoarthritis verändert sich nicht Eine verlässliche innere Fixierung macht die postoperative Ruhigstellung im Gipsverbande unnötig Tupmans Platten erwiesen sich als nützlich Mittels ihrer Verwendung kann man eine bessere Vorsorge für die Beweglichkeit des Hüft und Kniegelenkes treffen und die Zeit der Wiederherstellung abkürzen

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FROM THE ORTHOPAEDIC DEPARTMENT OF KAROLINSKA INSTITUTET
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ARTHROPLASTY OF THE KNEE USING AN ENDOPROSTHESIS

8 years experience

By

BORJE WALLDIUS

In 1951 the author elaborated a method of operation for arthroplasty of the knee where after resection of the joint an endoprosthesis of acrylic resin constructed as a hinge joint was inserted Primary results after this method were considered good

Now 8 years after the first operations were performed a number of questions may with reason be considered

Have the good primary results continued during this period?

Have late complications occurred since the introduction of this method which may have suppressed or eeven reversed the optimism?

Has the operation any chance of becoming a routine method or is it only suitable for certain extreme cases?

Has the method proved to be suitable for the mechanical and biological requirements?

MATERIAL

The total number of operated patients is 51 13 patients have been operated bilaterally The total number of arthroplasties is therefore 64

Indications for operation	
Rheumatoid arthritis	43 cases
Degenerative arthritis	5 cases
Morbus Bechterew	2 cases
Status post septic arthritis	1 case

In order to be able to judge the results it is necessary to review the indications for operation The first operations using a new method are

regarded as experimental. One is obliged to try and reduce the risk of impairment after operation to the minimum. This has been achieved by chosing those patients who are already so disabled that an unsuccessful operation could hardly cause a change for the worse. Those patients were mostly severely disabled rheumatics with flexion contractures and pains in the knee joints where all conservative treatment had failed to help.

20 patients have been "wheel chair" cases. 10 of these have had bilateral arthroplasties performed. Of these 10 one had been in a wheel chair for 11 years, one for 10 years, one for 9 years, one for 7 years, one for 5 years, two for 3 years and three for 2 years. The remaining patients had had great difficulty in using crutches or walking sticks, could manage a few steps indoors or only very short distances out of doors.

A significant atrophy of the quadriceps muscle had been present. 15 of the patients were, owing to the forced lack of movement, rather corpulent.

In many cases the suffering had caused mental depression. One patient was transferred from a psychiatric clinic, to which she had been admitted after an attempt to commit suicide.

The age of the operated patients varied between 29–79 years, with an average of 51 years.

The above mentioned features have generally been regarded as contra-indications for arthroplasty of the knee joint. This must be considered when evaluating the results.

RESULTS

There were very good results with 41 arthroplasties (64 %), good results with 6 arthroplasties (10 %), poor results with 17 arthroplasties (26 %). When previous arthroplasty methods were used the results were about 50 % good and 50 % bad. The endoprosthesis *method has in spite of the most unfavourable conditions shown an* increase of good results by 24 %. A very good result means that the patient has a pain-free, stable joint with a range of mobility of 50°–90°. The average range of mobility in this group is 81°. Walking ability has been regained or greatly improved.

One of the patients with a good result has persistent pain, though not severe, and he walks without a limp. Two patients lack full stability in the joint. Two patients have become permanently bedridden as

a result of their progressive diseases polyarthritis and Morbus Bechterew The operated knees however have a mobility range of 80 and 90 respectively and are considered to be in good condition compared with the rest of the joints which have been completely destroyed These patients are quite unable to walk or even stand upright One patient has only 45 range of mobility but is otherwise fit

Time of observation for the whole material this covers a period of 8 years to 2 months In 7 cases of successful arthroplasties the observation period was 8–5 years in 13 cases 5–3 years in 18 cases 3–1 year and in 9 cases less than 1 year

Complications Complications can be grouped into those causing a poor final result and those not influencing the result Moreover there are early complications occurring at the time of operation and late complications

Early complications consisted of pulmonary embolism in one case and septicaemia in another both with a fatal outcome

In one case a disruptured wound depending on insufficient immobilization became infected and led to amputation Another case with infection of the wound and paralysis of the peroneal nerve led to the same result

In a case of Morbus Bechterew where the intention was to enable the patient to obtain a sitting position the prosthesis was extracted after skin necrosis and infection

In three cases considerable rigidity in the joint was present postoperatively A possible explanation for this may be that owing to the acrylic prosthesis being a little too big an electric drill was used to remove the protruding parts after the prosthesis had been inserted It was therefore impossible to avoid acrylic particles settling in the joint and causing irritation resulting in fibrosis of the joint In order to relieve the rigidity the patella was extirpated but without success An infection flared up and an arthrodesis was finally performed This resulted in an ankylosis and healing of the infection

In 4 more cases infection of the wound made it necessary to perform an arthrodesis with ankylosis and healing of the infection As regards walking ability these patients with arthrodesis have been improved by the operations

Consequently the greatest risk involved by operation is infection An infection in the skin has only a short distance to the joint In a number of cases the sutures have been removed too soon and the wound has gaped open Similarly physiotherapy has been commenced before

the wound has been properly healed Complete healing usually takes 3 weeks

A resistant strain of staphylococcus aureus has been a difficult antagonist

A persisting rigidity with only 20 range of mobility + pain was registered in one case

In two arthroplasties the femur part was driven in at a wrong angle so hindering full correction of a flexion contracture

Of the late occurring complications there was one case of septic arthritis The patient had had an open intraarticular fracture which was followed by septic arthritis and a fistula which greatly lengthened the time of healing There were big adhesive scars on the anterior side of the joint and the knee had a varus position This became more pronounced by a partial amputation of the foot also in a varus position It was suggested that the leg should be amputated at thigh level but the patient preferred to undergo an arthroplasty of the knee first After operation the joint had a mobility range of 35 but 14 months later the infection flared up again and a new septic arthritis made amputation necessary

Fracture of the medullary pin of the prosthesis has necessitated the change of prosthesis in 2 cases In one case the patient fell and injured the knee 4 years and 7 months after the operation In the second case it was a fatigue fracture After change of the prosthesis good results were again achieved

In one case of Morbus Bechterew where all the joints of the body were ankylosed a range of mobility of 20 was obtained in the knee After operation the previous flexion contracture of 60 could be adjusted This patient had also had a bilateral arthroplasty of the hip After 11 years in a wheel chair she learnt to walk

Among complications not causing impairment there were 2 cases with a lesser degree of paralysis of the peroneal nerve This was repaired in both cases

Necrosis of the skin in 2 cases and thrombosis in another did not cause any later inconvenience

This applies also to 4 cases with fracture of the tibial pin of the prosthesis This can be revealed roentgenologically but not clinically The stability of the joint has been maintained due to the fact that the central part of the prosthesis is firmly fixed in the condyles The greater part of its circumference is surrounded by an osteophytic wall

Summarizing the complications it may be said that most of them

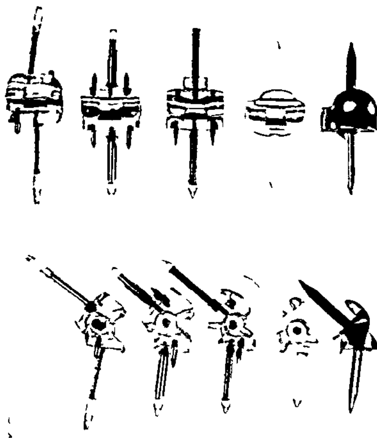


Fig 1

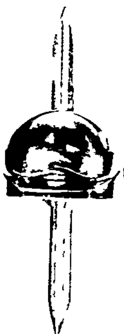
occur in connection with operation and that late complications are relatively few. The greatest risk involved is of infection. This difficulty can be overcome by performing an arthrodesis which has produced ankylosis in all the cases.

PROSTHESIS

The construction of the prosthesis has been modified (Fig. 1). At first the medullary pins were long and could cause conflict with the cortex and now they have been shortened. In the first prosthesis there were also small pins of stainless steel on the central part to hinder rotation of the prosthesis around its longitudinal axis. These have n



A



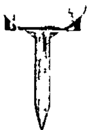
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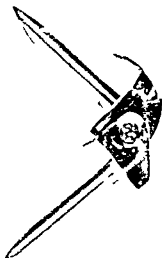
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D



E

Fig. 2



Fig. 3
Roentgenograms with vitallium pro[illegible]the[illegible]

been replaced by lips which produce the same effect and moreover the lip on the femur part forms a joint surface for the patella.

The first prostheses (58) were made of acrylic resin, now vitallium is used since it is found to be stronger and more durable (Figs. 2, 3). The axis is covered with a layer of teflon, which has a low friction coefficient and great resistance to wear and tear. It was possible to manufacture the prosthesis in smaller sizes. The height of the central part was reduced from 48 mm in the first prosthesis to 28 mm in the vitallium prosthesis. The prosthesis is manufactured by AB [illegible] Werner in Stockholm.

OPERATION

(Figs. 4–15)

The operation should be performed in a bloodless field. All the various types of skin incision were used and the incision according to [illegible] proved most suitable. The capsule and ligamentum patellae are divided at the level of the skin incision. The skin is not loosened from the capsule. The joint surfaces are resected as in an arthrodesis. A flat piece of bone about 1 cm thick is taken from the tibia and one about 1 cm thick from the femur. The posterior parts of the femur condyles and the posterior edge of the tibia are chiselled off in order to [illegible] between these parts with bending movements in the joint [illegible] instrument is required for the insertion of the prosth[illegible]


Fig 4


Fig 5


Fig 6


Fig 7


Fig 8


Fig 9



Fig 10



Fig 11



Fig 12



Fig 13



Fig 15



Fig 1

La technique operatoire qui est extremement simple est decrite D un point de vue biomecanique les conditions pour obtenir de bons resultats des operations par endoprothese paraissent meilleures dans l articulation du genou que dans celle de la hanche

Il faut envisager d amplifier successivement les indication de cette operation puisque cela s est montre que les resultats primaires ont pu etre maintenus pendant plusieurs années (max 8 ans)

ZUSAMMENFASSUNG

Der Verfasser gibt einen Bericht uber achtjahrige Erfahrungen mit seiner Methode der Arthroplastik des Kniegelenks wobei eine Endoprothese verwendet wurde 51 Patienten wurden auf diese Weise operiert davon 13 auf beiden Seiten zusammen ergo 64 Arthroplastiken Die Hauptindikation stellte rheumatische Arthritis dar die von so starken Beuge Kontrakturen im Kniegelenk begleitet war dass die Gehfahigkeit während vieler Jahre (maximal während 11 Jahren) vollkommen aufgehoben oder weitgehend eingeschränkt war Die operative Technik die einfach ist wird beschrieben Vom biochemischen Standpunkt ausgesehen scheinen die Verhaltnisse zur Erreichung guter Resultate durch die Operationen mit Endoprothesen im Kniegelenk besser zu sein als in der Hüfte Wie angedeutet wurde hielten sich die guten primären Ergebnisse viele Jahre (maximal 8 Jahre) hindurch sodass es gerechtfertigt erscheinen mag allmahlich die Indikation fur diese Operation zu erweitern

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FROM THE BEILINSON MEDICAL CENTER OF KUPATH HOLIM PETAH TIQVAH

CORRECTION OF SPASTIC EQUINOVARUS DEFORMITY IN ELDERLY HEMIPLEGICS BY TENOTOMIES

By

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With the increasing average age of men more and more people are suffering from damage of the locomotor apparatus caused by the failure of the vascular supply to important neurologic centers. Cerebral hemorrhage is one of the most dreaded incidents in the aged, leaving the patient if not killing him with more or less severe motor damage mainly of spastic type. Other conditions, like central neurologic diseases or surgical interventions at the brain, may have similar results.

Many of these patients are spastic hemiparetics. If they recover, rehabilitation tries to restore their walking ability by exercises, mostly using a stick in the healthy hand (1, 4, 5). Very often a spastic equinovarus deformity of the foot makes walking difficult. This deformity increases with the recovery of muscle tonus during the first 6 to 12 months after the onset, being more pronounced the moment the foot swings forward to meet the ground during walking, but often almost disappearing during standing. Callouses develop on the lateral border of the foot, a faulty step mechanism is instituted, where the foot steps first on the outer toes, later bends into dorsal flexion and finally reaches the ground with the heel. In severe cases the heel never reaches the ground.

To correct this deformity various splints are used, connected to the shoe and activated by springs which pull the foot into dorsal flexion (2). These splints may correct the deformity satisfactorily if there is very little spasticity. Most of these patients, however, prefer to walk with some deformity rather than to wear the additional weight of the splint. If the deformity is strong, the splint may have the effect of pulling the lower leg forward, resulting in a flexed knee during weight bearing.

The best solution for this trouble is surgical correction It eliminates the necessity of a cumbersome splint and removes the spasticity of the foot Ankle fusions have been used as sound procedures to correct such a deformity but they are major interventions considering the frail health of these patients It is much easier to correct the deformity by tenotomy of the spastic and deforming muscles

Tenotomies have been performed as early as in 1838 as blind tenotomies by *Stromeyer* (7) to correct congenital and similar conditions There was much enthusiasm about this simple operation at the time but as recurrences happened very often and early the method was later abandoned Tenotomies as treatment of choice are still used to correct contractures in special cases (3 6) mostly in spastic conditions where surgery of a more reconstructive kind does not seem to give better results

Tenotomy to correct the deformity in question is a simple procedure as it may be done with a single incision and accomplished in about 15 minutes in local infiltration anaesthesia and is therefore not distressing for the patient

THE OPERATION

The patient is placed in prone position or on the side with the paralysed leg near the table Local anaesthesia is given to the region of the medial malleolus and the Achilles tendon A curved incision is made freeing the medial posterior plane of the lower tibia (Figs 1 and 2) The fascial sheath is opened about two inches above the malleolus The tendons of the posterior tibialis and the flexor digitorum longus muscles are identified and a piece of these tendons of one inch in length is resected The neurovascular bundle is avoided the tendon of the flexor hallucis longus is freed laterally to it and divided likewise If there is still spasticity holding the foot in equinus the Achilles tendon is freed for about 6 inches through the same incision Two transverse cuts are made in it each dividing half of the tendon fibers The heel cord is now lengthened by sliding between the cut fibers according to the technique of *White* (8) by dorsal flexion of the foot The skin only is closed and a light below knee walking cast is applied for three weeks holding the foot in correct alignment No heel is applied to this cast and the patient is encouraged to walk the day after the operation straight on the sole part of the plaster He is discharged two to four days later After the removal of the plaster elastic bandages are used as long as swelling persists around the ankle

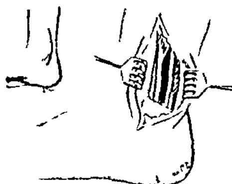


Fig 1

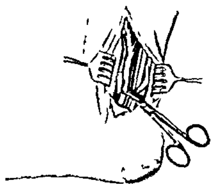


Fig 2

Fig 1 Inset Skin incision After opening of the fascia the tendons of the Tibiali posterior and the Flexor digitorum longus are identified

Fig 2 After division of the tendons of tibialis posterior and Flexor hallucis longu: resection of a tendon piece of one inch in length and dissection of the flexor halluci longus tendon The latter tendon is divided care being taken not to injure the neurc vascular bundle

DISCUSSION

During the last three years 8 patients have been operated accordin to this procedure (Figs 3 and 4) There were no adverse effects in an of these cases In one case slight calcaneus deformity resulted by over correction of the heel cord but it did not impair the walking ability o the patient One of the patients suffering from Parkinson s disease an being a spastic paraplegic after brain surgery has asked now for th same operation on the unoperated better leg There were no recurrence in this short follow up period but not many of these patients wi achieve a long follow up period because of the nature of the underlyin disease Even if this operation had a lasting effect for only a few year it still would be worth while to use it On the other hand it seems im possible to get recurrence of the varus component of the deformity a its cause namely the invertor muscles has been radically eliminatec The only recurrence theoretically possible should be a recurrence of th equinus deformity by additional shortening of the Achilles tendon which did not occur in these cases

The simplicity of the procedure the immediate correction of the de formity and the improvement of the gait in a very short time are ac vantages which make the surgical correction of the deformity r

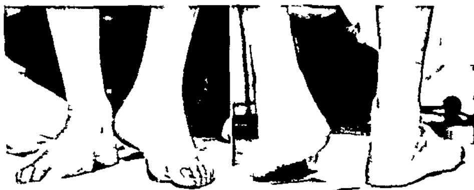


Fig 3
Left spastic equinovarus in standing



Fig 4
Same case 6 months after correction by flexor inverter tenotomy and Achilles lengthening

commendable even in this group of patients with a rather unhappy outlook for their far future

SUMMARY

With the increasing age of the human being more people suffer from spastic paralysis caused by cerebral hemorrhage Spastic equinovarus deformity in these patients makes walking more difficult and orthopaedic appliances used for correction of the deformity are not very successful

A simple operation is advised for these patients which eliminates spasticity and the need for corrective apparatus In local anaesthesia the

tendons of the toe flexors and the tibialis posterior are cut and the Achilles tendon—if necessary—is lengthened through the same incision

The effect is immediate The patients are allowed to resume weight bearing the day after operation with a protective walking plaster which is discarded after 3 weeks In 8 cases operated there were no adverse results or complications making this operative procedure a simple solution for this problem of elderly and weak patients with a precarious state of health

RESUME

Avec l elevation de l age chez les etres humains le nombre des cas de paralysie spastique causee par hemorragie cerebrale s accroit aussi La deformite spastique equino varus chez ces malades rend la marche difficile et les moyens orthopediques utilises pour corriger la deformite n ont guere de succes

Une simple operation est recommandee pour ces malades Elle elimine la spasticite et la necessite d appareils de redressement Sous anesthesie locale les tendons des flechisseurs de l orteil et du ligament tibial posterieur sont coupés et le tendon d Achille – si cela est necessaire – est allonge a travers la meme incision

L effet est immédiat Il est permis au malade de faire supporter au pied le poids du corps le jour qui suit l operation avec un bandage en platre de protection qui est retire au bout de trois semaines Dans 8 cas operés jusqu ici il n y a pas eu de mauvais resultats ou de complications ce qui fait que ce procede operatoire apporte une solution simple a ce probleme chez les malades ages et faibles dans un etat de sante precaire

ZUSAMMENFASSUNG

Als eine Folge des hoheren Alters das von den Menschen erreicht wird leiden eine zunehmende Zahl von ihnen an durch Gehirnblutung hervorgerufener spastischer Parese Spastische equino-varus Deformitat macht das Gehen für diese Patienten schwieriger und orthopedische Apparate zur Korrektur der Deformitet sind nicht sehr erfolgreich

Eine einfache Operation die die Spastizitat ausschaltet und die Notwendigkeit fur korrigierende Apparate uberflüssig macht wird bei diesen Patienten angeraten In ortlicher Betaubung werden die Sehnen der Zehenbeuger und des m tibialis posterior durchgeschnitten und die Achillessehne wird wenn notwendig von derselben Inzision aus verlangert

Die Wirkung ist eine sofortige Die Patienten durfen am Tage nach der Operation mit einem beschutzenden Gehgips belasten Der Gips wird nach 3 Wochen entfernt In 8 operierten Fallen traten keinerlei unerwartete schlechte Ergebnisse oder Komplikationen auf so dass man dieses operative Verfahren als eine einfache Lösung fur das Problem alterer schwacher Patienten mit schlechtem Gesundheitszustand ansehen kann

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EARLY CHANGES OF THE GROWTH ZONE IN RABBIT FOLLOWING ROENTGEN IRRADIATION

By

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It has long been known that local roentgen irradiation in sufficiently large doses in growing animals causes an arrest of growth and bony closure of the epiphyseal plate, resulting in various deformities. Numerous publications have been devoted to this phenomenon, the earliest dating as far back as 1903. Histologic changes of the epiphyseal plate have been demonstrated 2 days after irradiation in a dose of 400 r (Bisgaard and Hunt 1936). In rats retardation of growth has been produced by doses over 650 r, whereas complete arrest of growth was achieved if the dose exceeded 1335 r (Barr et al. 1943). Careful histologic studies by Hinkel (1943) have provided evidence of changes in the epiphyseal plate and the adjoining cancellous bone in animals examined at the earliest 2 days after irradiation. As far as can be ascertained, no attempts have as yet been made to determine whether changes occur prior to this time.

60 hours after irradiation Hinkel observed changes in the cartilage cells, which appeared swollen, stained differently and showed a changed nuclear structure. The height of the cartilage columns increased and after a few more days the individual columns contained an increased number of cells. One of the alterations observed in the zone of calcification was a change and partial disappearance of the osteoblasts. They were found freely in the lumen, whereas the bony trabeculae adjoining the epiphyseal cartilage were not covered by osteoblasts. The capillaries, which in addition to other methods were studied by injection of Indian ink, likewise appeared damaged. Hinkel considered his observations to constitute evidence of primary damage to cartilage cells, osteoblasts and capillaries. As one of the secondary phenomena

following these injuries he regarded the decreased disintegration of cartilage cells in the zone of calcification This implied that the cartilage cells which were not destroyed enclosed in calcified matrix might be shifted down to the metaphysis and could after even a short time be observed in the compact bone Hinkel has also studied the changes apparent at a later stage after irradiation Detailed information on these observations can be found in his original publication

Stimulated both by the results of our own earlier studies regarding the effect of papain on epiphyseal cartilage and by the rapid development of epiphyseal research as a result of the current interest in osteo lathyrism our attention was directed towards other methods of producing damage to the epiphyseal cartilage such as roentgen irradiation As earlier authors seem to have disregarded the changes which occur within 2 days of roentgen irradiation of the epiphyseal and metaphyseal areas we felt justified in devoting a detailed study to these early changes In addition to histologic examination our study included a roentgenologic and microradiographic examination

MATERIAL AND METHODS

The animals selected for the experiments were young white rabbits weighing from 200 to 400 g During the roentgen irradiation the rabbits were placed in a lead cylinder with 3 mm thick walls The right lower foreleg was drawn through a hole in this cylinder and fixed to the out side with tape after which the hole was covered with lead to prevent any radiation from penetrating into the cylinder Radiation was ad ministered through a 4 AL filter at 220 kv and at a focus skin distance of 40 cm The doses varied from 200 r to 2000 r The animals were killed by air embolism from 6 hours to 10 days after irradiation Immediately after death both forelegs were removed and roentgenographed side by side As a next step the radius and ulna from both sides were fixed in 10 % neutral formalin The radius was then divided lengthwise by means of a circular saw and one of the halves embedded in methyl metacrylate The other half of the radius and the ulna following de calcification in formic acid and natrium citrate were embedded in paraffin and cut into sections of 5 μ thickness Staining was done with haematoxylin eosin The plastic embedded halves of radius were ground down to various thicknesses ranging from 800 to 100 μ A number of specimens were not embedded but immediately cut down with a dental saw into 800–1000 μ thick slices



b

c

d

Fig. 1a–d

Radiographs left (L) and right (R) forearm. Roentgen irradiation over right forearm.

a 48 hours after irradiation (300 r).
On the right side there is a transverse zone with a lower degree of mineralization in the metaphysis close to the epiphyseal cartilage. The change is seen in both radius and ulna.

b 48 hours after irradiation (1500 r).
Same finding as in a.

c 96 hours after irradiation (1250 r).
The transverse zone of low mineralization is shifted further down the metaphysis.

d 10 days after irradiation (1000 r).
New zone of low mineralization is seen centrally. The dense area of the metaphysis close to the epiphyseal cartilage is wider on the right side and has a higher degree of density than on the left side.

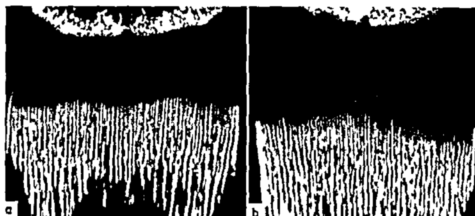


Fig. 2a–b
Microradiographs. Distal radial epiphyseal cartilage zone.

a. Left side. Untreated. The picture shows normal mineralization.

b. Right side. 48 hours after irradiation (1000 r).
A transverse zone of lower mineralization is demonstrated. The bone spiculae are in this zone broken or thinner than normal.

The ground sections were used for a study of the distribution of mineral salts. The radiation source was a Philips diffraction unit with Cu anode. The specimens were placed directly in contact with extremely fine grained photographic emulsion. Exposure was made by roentgen rays generated at 24 kv. The pictures obtained in this way were enlarged by photomicrography.

RESULTS

Roentgen examination

In all cases both forelegs were examined by roentgen immediately after death. Neither 6 hours nor 24 hours after irradiation can any certain changes be detected in the roentgenogram. On examination 48 hours after irradiation a typical change can be observed in the distal ends of the radius and ulna in all animals exposed to doses of at least 300 r. This change appears as a narrow zone of decreased density across the dense metaphyseal area close to the epiphyseal cartilage representing a change in the mineralization of the primary cancellous bone (Figs. 1a and b). If the doses are increased to 1500–2000 r this clear zone becomes wider and less sharply delimitated (Fig. 1b). The same change can be observed 96 hours after irradiation but the zone is then somewhat wider and has shifted further down the metaphysis (Fig. 1c).

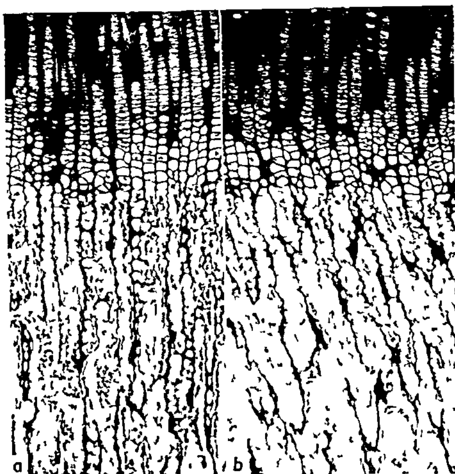


Fig. 3a, b

Distal radial epiphyseal cartilage zone. Haematoxylin eosin. 115 ×

a. Left side. Untreated. Normal histologic picture.

b. Right side. 6 hours after irradiation (1000 r).
There are no changes in the epiphyseal cartilage. In the primary spongiosa there is a very low number of osteoblasts.

If more time is allowed to pass after irradiation, the clearer zone disappears and instead the metaphyseal area of the exposed limb is found to have a higher degree of density over a larger area in comparison with the unexposed side (Fig. 1d).



Fig. 4a–b
Distal radial metaphysis close to the epiphyseal cartilage.
Haematoxylin-eosin, abt. 1000 ×

a. Left side. Untreated. Normal osteoblasts situated close to the bone spiculae.

b. Right side 6 hours after irradiation (1000 r).
The osteoblasts are not normal. The structure of the nucleus is more diffuse and there is a higher granulation of the cytoplasm. The osteoblasts are not in the normal way situated close to the bone spiculae.

Microradiographic examination

For a more detailed investigation into the nature of the clearer zone described above, a study has been made of microradiographed sections.

The zone of decreased density can be identified in the microradiogram provided the sections used are not too thin. If the specimens are ground down to 100 μ no certain changes can be detected in the microradiograms, whereas they are on the other hand quite unmistakable in specimens of 250–800 μ thickness.

The change is here, as in the roentgenograms, apparent as a fairly sharply delimitated zone of decreased density straight across the bony trabeculae (Figs. 2a and b). The individual bony trabeculae within the area affected by the change appear to be interrupted or have become hour-glass shaped.

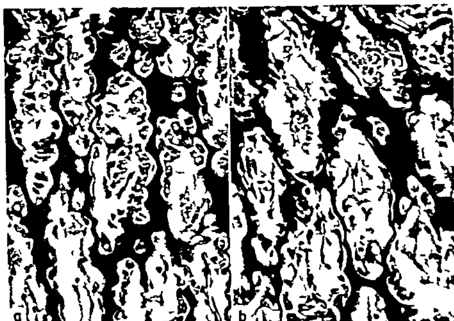


Fig. 5a–b

Distal radial metaphysis close to the epiphyseal cartilage. Haematoxylin-eosin abt. 190 ×

a Left side. Untreated. Normal histologic picture.

b Right side 24 hours after irradiation (1000 r).
The number of osteoblasts is lower than on the untreated side. The nuclei of the osteoblasts are mostly pycnotic.

Histologic examination

The histologic examination has primarily been concentrated upon the changes that can be observed within 48 hours of irradiation. In addition, in order to have a basis of comparison with earlier investigations, the changes apparent 10 days after exposure are reported.

The results presented below are based on examination of two litters, one of which was given doses of 500 r, the other of 1000 r.

6 hours after irradiation

No changes are apparent in either the cells or the matrix of the epiphyseal cartilage. Marked changes can be observed in the part of the primary cancellous bone immediately adjoining the epiphyseal car-

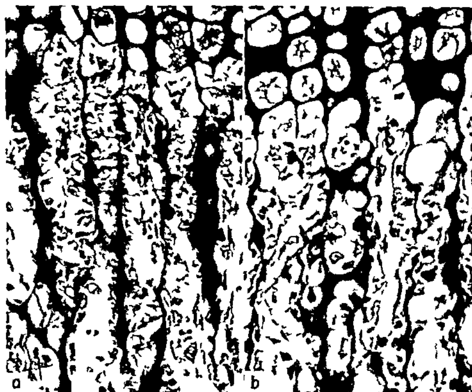


Fig. 6a, b

Distal radial epiphyseal metaphyseal zone. Haematoxylin eosin, abt. 200 ×

a. Left side. Untreated. Normal number of osteoblasts and other cells. The bone spiculae are without breaks.

b. Right side 48 hours after irradiation. The number of osteoblasts and other cells is diminished. The osteoblasts seem to be dead and are situated free in the cavities. The bone spiculae show several breaks.

tilage. On the exposed side the number of osteoblasts is considerably reduced. The same observation applies to the other cells found in the marrow cavities of the cancellous bone (Figs. 3a and b). The remaining osteoblasts appear damaged. Their nuclear structure is less regular than normal and their cytoplasm shows an increased granulation (Figs. 4a and b). The osteoblasts are furthermore largely found detached from the bony trabeculae, which normally does not occur. On the damaged side they are found freely scattered in the lumen, which in addition contains detrital matter. It would seem that the changes in the osteoblasts decrease with increased distance to the epiphyseal cartilage.

The illustrations presented here (Figs 3 and 4) refer to animals exposed to radiation of 1000 r The animals irradiated with 500 r show similar and equally severe changes

24 hours after irradiation

At this stage the changes resemble those described in the foregoing but they have to some extent increased in severity There are still no certain changes to be detected in the cartilage cells The cavities of the cancellous bone on the exposed side contain a considerably lower number of cells and capillaries The red blood corpuscles appear to lie free instead of being enclosed by capillary endothelium The changes in the osteoblasts are clearly visible in Fig 5b on comparison with Fig 5a On the exposed side (Fig 5b) these cells are smaller and shrunken To some extent they occur freely in the cavities of the cancellous bone where they lie apparently dead The primary trabeculae in the metaphysis furthermore appear narrower than on the unexposed side mainly due to the fact that no normal bone deposit has taken place This appears clearly from Figs 5a and 5b in Fig 5a a relatively wide acidophilic bone seam can be seen on both sides of calcified cartilage matrix In several places on the exposed side breaks appear in the trabeculae in far larger number than is ever seen in normal specimens

48 hours after irradiation

There are still no certain changes to be detected in the cartilage tissue There remains an unmistakable and large insufficiency of cells in the marrow cavities The cytoplasm of the osteoblasts is shrunken while their nuclei are more or less pycnotic The cells lie largely detached from the trabeculae Hematopoietic cells are lacking entirely and it is difficult to find any capillaries on the exposed side (Figs 6a and b)

10 days after irradiation

At this stage the epiphyseal cartilage is seen to have undergone a marked change (Fig 7a) The proliferating cartilage cells which normally are arranged in regular columns are now concentrated in dense irregular clusters separated by disintegrated matrix Even the hypertrophic cells down in the zone of calcification have collected in clusters The epiphyseal metaphyseal border which normally is



Fig 7a–b

Distal radial epiphyseal metaphyseal zone Haematoxylin eosin
Right side 10 days after irradiation (1000 r)

a abt 75 × The epiphyseal cartilage is severely damaged There is irregular organization of the cartilage with the cells clustered and with defibrillated matrix The marrow cells have increased in number

b abt 295 × Shifted down in the metaphysis there are cartilage cells which are not disintegrated in the normal process of the endochondral growth

straight and even is now extremely irregular The stainability of the *epiphyseal cartilage appears to be unchanged*

In the zone of primary cancellous bone (Figs 7a and b) the normally regular straight and close ranked bone spiculae are lacking The trabeculae are more sparsely distributed shorter than normal and irregularly shaped sometimes spirally distorted The number of osteoblasts and other cells remains considerably reduced in the zone of primary cancellous bone The hematopoietic cells in the free marrow cavity appear to have increased in number again

It is particularly interesting to observe surviving cartilage cells within the trabeculae in various places fairly far down in the metaphysis these cells have not been destroyed as usual during the process of calcification (Fig 7b)

DISCUSSION

Owing to a large number of both histologic and roentgenologic publications on the subject the detrimental effect of roentgen irradiation on epiphyseal cartilage has long been known Earlier studies have been concerned with the changes apparent in the growth zone at a fairly late stage after exposure and in addition with the retardation or complete arrest of endochondral growth produced by irradiation

In the present investigation we have been able to demonstrate that from 2 to 4 days after irradiation of the foreleg in rabbits in doses varying from 300 r to 2000 r roentgenologic evidence can be found of changes in the mineralization of the part of the ulnar and radial metaphysis adjoining the epiphyseal cartilage In order to find an explanation of this phenomenon the exposed limbs were subjected to a microradiographic and histologic examination A transverse zone of decreased density visible in the roentgenograms was in the microradiograms represented is an interruption of hour glasslike narrowing of the individual bony trabeculae The histologic examination provided as early as 6 hours after exposure evidence of primary damage to the osteoblasts in the area adjoining the epiphyseal cartilage The number of osteoblasts was reduced and to some extent they had become detached from the bony trabeculae and were found free in the lumen Twenty four hours after irradiation the osteoblasts appeared for the greater part necrotic In addition a change in the capillaries in the marrow cavities of the cancellous bone could be demonstrated The normal deposit of osteoblasts on the bone spiculae did in many places not take place which meant that the bony trabeculae were narrower than normal and here and there showed breaks The epiphyseal cartilage itself did not appear to have undergone any major changes during the first 48 hours after exposure but 10 days after irradiation it showed severe alterations From the fact that fairly far down in the metaphysis surviving cartilage cells were found enclosed in the bony trabeculae it appeared that growth to some extent had continued during these 10 days

Our investigations indicate that the effect of the irradiation is con

centrated upon the osteoblasts immediately adjoining the epiphyseal cartilage and possibly simultaneously affects the capillaries present in this area The osteoblasts at a further distance from the epiphyseal cartilage appear less damaged and are probably less sensitive to the radiation This may be connected with the fact that the osteoblasts closest to the cartilage are most active The altered mineralization can probably be explained as a secondary effect following upon the damage to the osteoblasts A secondary phenomenon to the capillary damage described above is furthermore undoubtedly the failure of certain cartilage cells in the zone of calcification to disintegrate as usual instead the intact cells are shifted down with the cartilage matrix to the metaphysis in the course of the growth process It seems that the damage to the epiphyseal cartilage itself does not materialize until from 48 hours to 10 days after irradiation which probably explains the continued growth during the course of the experiment This agrees with for instance Regen s and Wilkins (1936) findings from roentgen absorption measurements of exposed growing skeletal structures They demonstrated that following irradiation in a dose of 2000 r the exposed animals stopped growing at some time within one month after the treatment and that irradiation even if given in such large doses did not produce an immediate effect

Our results show that the effect of roentgen irradiation on the epiphyseal cartilage is of an entirely different character to that produced for instance by injection of papain or that seen in osteolathyrism Roentgen irradiation produces primary damage to the osteoblasts whereas both following injection of papain and in osteolathyrism the primary changes affect the epiphyseal cartilage

On the whole the present findings showed good agreement with those reported by Hinkel (1943) among others whereas the changes 6 and 24 hours after irradiation merely differed in intensity from those observed after 48 hours

SUMMARY

The early changes produced by roentgen irradiation of the distal radial and ulnar epiphyses in young rabbits are described Following radiation in doses of at least 300 r the roentgenogram shows a zone of decreased density straight across the metaphysis adjoining the epiphyseal cartilage This clear zone can in microradiograms be identified as an interruption or narrowing of the bony trabeculae The histologic

findings indicate that the damage primarily affects the osteoblasts and capillaries in the portion of the metaphysis which adjoins the epiphyseal cartilage. As a result of this bone deposit on the calcified intercartilaginous septa fails to take place everywhere. No changes can be demonstrated in the epiphyseal cartilage within the first 48 hours following irradiation, but severe changes are evident after 10 days. During this period a clearly perceptible growth of the bone occurs.

RESUME

Description des modifications precoces produites par l'irradiation roentgen sur l'epiphyse distale radiare et ulnaire chez les jeunes lapins. A la suite de radiations a doses d'au moins 300 r, le roentgenogramme montre une zone de densite diminuee juste au travers de la metaphyse adjacente au cartilage epiphysaire. Cette zone claire peut etre identifiee sur le microradiogramme comme une interruption ou un retrecissement des trabecules osseux. Les trouvailles histologiques indiquent que le dommage primaire atteint les osteoblastes et les capillaires dans la portion de la metaphyse qui est contigue au cartilage epiphysaire. Il en resulte que le depot osseux sur la paroi intercartilagineuse calcifiee ne se fait pas régulierement partout. On ne peut constater aucune modification du cartilage epiphysaire pendant les 48 heures qui suivent l'irradiation, mais des modifications graves apparaissent de toute evidence apres 10 jours. Durant cette periode il se produit une croissance nettement perceptible de l'os.

ZUSAMMENFASSUNG

Die durch Rontgenbestrahlung hervorgerufenen fruhzeitigen Veranderungen der distalen Radius- und Ulnaepiphysen junger Kaninchen werden beschrieben. Nach Bestrahlungsdosen von zumindest 300 R zeigen Rontgenaufnahmen eine Zone herabgesetzter Dichtigkeit quer uber die dem Epiphysenknorpel benachbarte Metaphyse. Diese klare Zone kann im Mikrorontgenbilde als eine Unterbrechung oder Verschmalerung der Knochentrabekel erkannt werden. Die histologischen Befunde deuten darauf hin, dass in erster Reihe die Osteoblasten und Kapillaren in dem Epiphysenknorpel benachbarten Teile der Metaphyse geschadigt werden. Das Resultat davon ist ein Versagen der Knochenablagerung in die verkalkten intercartilaginaren Septa auf der ganzen Linie. Veranderungen am Epiphysenknorpel innerhalb der er-

sten 48 Stunden nach der Bestrahlung können nicht nachgewiesen werden, aber schwere Veränderungen sind nach 10 Tagen sichtbar. Während dieses Zeitraumes geht ein deutlich wahrnehmbares Wachstum des Knochens vor sich.

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A DISORDER OF OESTROGEN METABOLISM AS A CAUSAL FACTOR OF CONGENITAL DISLOCATION OF THE HIP

By

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It is widely believed that the primary cause of dislocation of the hip in newborns is congenital dysplasia of the joint. An objection that can be raised against this concept, however, is that the dislocation is present already at birth and that undelayed treatment for a relatively short time is sufficient to prevent the development of dysplasia. In animals, however, experimental dislocation of the hip will be followed by dysplasia. In congenital dislocation of the hip the capsule is elongated, and it is this elongation that enables the femoral head to slip out of the acetabulum. This relaxation of the capsule appears to be secondary to generalized instability of the pelvis, a widening of the pubic symphysis being roentgenologically demonstrable in the presence of such a dislocation. This instability disappears within a few days (1). A similar instability of the pelvis ("pelvic insufficiency") is not uncommon in pregnant women, and it is believed to be due mainly to an excessive oestrogenic effect.

It was therefore thought that the instability of the symphysis demonstrable in newborns with congenital dislocation of the hip might be of similar origin. According to *Diczfalusy*, oestriol is the only hormone excreted by newborns and the amount excreted diminishes to very low values within the first few days of life (2, 3). *De Blieck* and *Schwers* found that newborn girls excreted twice as much oestriol as newborn boys (4).

The excretion of oestrogen metabolites by two newborn girls with congenital dislocation of the hip and by seven healthy newborn girls from the second to the fifth or sixth day of life are compared below. The oestrogen was determined by the method of *Brown* (5).

TABLE 1

Excretion of oestrogen metabolites in 7 normal new born girls and in 2 cases of congenital dislocation of the hip both new born girls. The amount of oestrogen is given as microgr./24 hours

	Case No	normal new born girls							cases of congenital dislocation	
		1	2	3	4	5	6		8	9
Oestriol										
Day of life	2	257	70		170		655	586	484	169
	3		111	113	3	115		122	45	40
	4	13				8		25	7	7
	5		12					11	1.5	
	6							5	3	
Oestrone										
Day of life	2	0	0		0		1.[illegible]	0.6	4.1	3.6
	3		0.9	0	0	0.1		0.6	0	[illegible]3
	4	0				0.4	0.6	0.[illegible]	1.4	1.3
	5		0					0	0.3	
	6							0	0	
Oestradiol 17β										
Day of life	2	0	0		0.[illegible]		0	0.5	3.6	1.8
	3		0	0	0.4	0.1		0.4	3.[illegible]	1.4
	4	0				0	0.7	0.2	1.8	0.9
	5		0					0	0.[illegible]	
	6							0		

The excretion of conjugated oestriol was of the same order in both groups. The excretion diminished rapidly. The urine from the controls contained only traces of conjugated oestrone and oestradiol 17β but the excretion of these oestrogens was appreciably higher in the infants with congenital dislocation of the hip and this increase persisted for at least the first four days of life. This increase supports the assumption that congenital dislocation of the hip may be secondary to a derangement of the oestrogen metabolism, particularly since oestrone and oestradiol 17β are the most active oestrogens.

Further studies including investigation of the metabolism of exogenous oestrogen are in progress.

SUMMARY

Analysis of urine from newborns with congenital dislocation of the hip showed a disorder of oestrogen metabolism. It is assumed that this

metabolic disorder plays a role in the causation of this disease of the hip

RESUME

L analyse de l urine des nouveaux nes chez lesquels a ete constatee une dislocation congenitale de la hanche fait apparaitre un trouble du metabolisme oestrogene Il est pretendu que ce trouble du metabolisme joue un role dans la cause de cette maladie de la hanche

ZUSAMMENFASSUNG

Durch Harnanalysen bei Neugeborenen mit angeborener Huftgelenksverrenkung konnte eine Störung des Oestrogenstoffwechsels nachgewiesen werden Es wird angenommen dass diese Stoffwechselstorung bei der Entstehung dieses Huftleidens eine ursachliche Rolle spielt

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CERVICAL DISK RUPTURE

Diagnosis and Therapy

By

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The term brachialgia is generally used as a collective name to describe the symptoms in painful conditions of the shoulder and arm. Many attempts have been made to form an etiologic classification and to differentiate various pathologico-anatomical or pathophysiological processes underlying such conditions. Broadly speaking, three different groups of morbid conditions have in recent years become more or less clearly distinguished, all despite their different pathogenesis apparently can produce a similar syndrome combining referred pain, vasomotor and circulatory disturbances and local changes in certain parts of the arm, mainly the shoulder joint (Duplay 1872, Dejerine 1891, 1916, Barre 1926, Codman 1934, Haggart and Allen 1935, Spurling and Scoville 1944, Spurling 1947, De Palma 1950, Frykholm 1951, Lindemann and Kuhlendahl 1953, Hult 1954, Jackson 1958, Bronger 1959-60).

Many painful conditions in the arm more or less affect circulation, producing such symptoms as a decreased resistance to strain expressed by easy fatiguability and an increased sensitivity to changes in temperature. Improvement of the local circulation achieved by cervical sympathetic blocks is therefore effective in reducing and sometimes completely allaying the symptoms. Scalenotomy, periarterial sympathectomy of the subclavian artery, cervical sympathicotomy or resection of the stellate ganglion likewise alleviate the symptoms, although sometimes their effect is only temporary. These methods have therefore at regular intervals recurred in the therapeutic arsenal (Reischauer 1955, Lidstrom 1959).

This paper was presented at the meeting of the Swedish Surgical Association on May 9, 1959 and at the Annual Congress of the Swedish Orthopaedic Association on December 5, 1959.

A characteristic feature of brachialgia is that the distribution of the pain over the arm varies Most severely and most frequently it involves he shoulder region and impaired mobility at the shoulder joint is often a concomitant finding It has been held that such decreased mobility may be the combined result of local changes in or around the joint and diminished activity as a result of the pains implying that such inactivity may cause shrinking of the capsule which in its turn results in a loss of mobility Decreased mobility has therefore not been considered as a decisive factor in the classification of cases according to their etiologic background Instead radiation of the pain down to the hand and fingers has been considered to indicate cervical nerve root lesions whereas pain localized to the shoulder joint alone has been regarded as indicative of joint involvement periarthritis bursitis tendinitis and rupture of the aponeurosis are some of the pathologico anatomical denoting such involvement Neurologic disturbances reflected by sory and reflex changes and pareses have been regarded as addi evidence for a diagnosis of nerve root involvement

The more and more general acceptance of cervical nerve root irri on as a clinical entity has made the demands for accurate diagnosis ingly more stringent the more so since favourable results have been reported from various quarters in regard to surgical intervention the form of removal of intervertebral disk material Exact diagnostic methods are particularly important if the type of cervical disk surgery to be accepted which entails an anterolateral excision when the sur has no possibility of seeing the lesion

In the selection of the material presented below we have in the first stance divided the brachialgia patients into two main categories one them comprising those with unimpaired shoulder mobility the other cluding the cases with decreased mobility From the former category e then selected those cases where the pain radiated down to one or ore fingers where the patients reported periodic stiffness of the neck nd furthermore had been unable to work for a fairly long time We t that it was in this group that we would be most likely to find *idence of cervical nerve root irritation* In co operation with the De rtments of Neurology Neurophysiology and Roentgenology the tients were subjected to a neurologic electromyographic and roent nologic myelographic discographic examination The series presented consists of 18 cases 7 of which were treated operatively

In the following I will report the results of our examinations and tempt to draw some conclusions from our observations



Fig. 1. Lateral view of degenerated cervical disks between C5–C6 and C6–C7.

MATERIAL

A total of 18 cases, including 5 women and 13 men, were studied. The patients varied in age between 34 and 64 years. The duration of the symptoms was for 12 patients 1½–13 years. In 4 cases the symptoms were of less than one year's standing. In 9 cases pain was felt in the right arm, in 7 cases in the left arm, in 2 cases the symptoms were bilateral. In all cases the pain corresponded to one or more of the segments C6–C8.

The series was thus, for the greater part, made up of patients around 50 years of age with, in the majority of cases, symptoms of several years' standing. Shoulder joint mobility was without exception unimpaired. In all cases the radiation of the pain down to the fingers permitted a classification by segmental involvement. The patients had all received routine conservative treatment including physical therapy, traction, and radio-therapy to the neck. In spite of this they were



Fig. 3
The myelographic appearance of the case from Fig. 2 in AP and lateral view. There are several defects on both sides between C4–C5, C5–C6 and C6–C7, mainly between C5–C6 and C6–C7.

greatly incapacitated and unable to work. Cervical sympathetic blocks had had no effect.

ELECTROMYOGRAPHIC EXAMINATION

The electromyographic study involved a various number of muscles in the hand, arm and shoulder and occasionally also the paravertebral muscles of the neck innervated by the posterior branches of the spinal nerves. Spontaneous fibrillation potentials were regarded as main criteria for denervation but they were ascribed definite pathological significance only when they were abundant or when they occurred in conjunction with positive sharp waves. Fasciculation potentials or a reduced number of active motor units during voluntary contraction

Electromyography was performed on ten patients and in five of them there were more or less obvious signs of denervation in one or



Fig 3
The same case as in the previous picture now X rayed while discography is performed during operation In all the degenerated inter spaces where the myelogram showed root compression there is a leakage of contrast posteriorly indicating prolapsed disks

several muscles In all these five cases myelography showed nerve root compression in two of them (both operated) no pareses or reflex abnormalities were revealed by ordinary neurological examination

Among those 5 patients where EMG provided no evidence for denervation there were two which showed no root compression on myelography nor any pareses on neurological examination two had a positive myelogram but no pareses and one (which was operated) had both a positive myelogram and a paresis

Electromyographic examination while constituting a valuable complement to the neurologic examination can obviously not replace a careful clinical analysis (Hagbarth)

ROENTGENOLOGIC EXAMINATION

All patients were examined by roentgenography and myelography with Pantopaque Details of these examinations are given in a separate paper by H Lodin

TABLE 1

Nonoperated cases with negative myelogram

Diary no.	Age	Sex	Duration of symptoms	Subjective symptoms in arm: Right	Subjective symptoms in arm: Left	Neurological examination: Sensation	Neurological examination: Reflexes	Neurological examination: Power	Electromyographic examination	Roentgenographic examination: Disk degeneration	Myelographic examination: Normal findings
0[illegible] 07 30	57	♀	1 ½ years		C6	(+)	—	—	–	—	—
03 06 15	0	♀	2 years		C6	–	—	—	–	—	—
08 11 06	51	♂	3 years		C8	–	—	—		C3 C4 C5 C6	—
24 03 10	35	♀	4 years	C7		—	—	—		—	—
25 10 03	34	♀	5 years		C8	—	—	—		—	—

EVALUATION OF THE CLINICAL EXAMINATION

The myelogram was considered negative in 5 cases. In 4 of these the plain roentgenograms were normal. In only one case did they show evidence of disk degeneration. In none of these 5 cases could any objective signs of neurologic changes be found. In two cases an electromyogram was made, but these provided no evidence of disturbances (Table 1).

Table 2 presents 6 cases, in 4 of which the symptoms were of less than one year's standing. The roentgenograms showed in all cases signs of degeneration in one or several disks. In 4 cases in this group there was evidence of neurologic disturbances; in 3 cases electromyographic changes were found. The myelogram was positive in all cases, indicating space-occupying lesions at the level of one or more nerve roots. In 5 of the 6 cases the myelographic changes occurred on the same side as the pains in the arm. In half of the cases the myelographic findings confirmed the clinically estimated level of involvement.

In the last group (Table 3), which consisted of 7 cases, neurologic disturbances were found in all but two. In all cases there was evidence of disk degeneration and the myelograms were positive. In two of the myelograms the level of involvement did not agree with that estimated on clinical examination.

Although it should be stressed that the small number of cases studied calls for caution in interpreting the findings, there seems to be a tendency towards agreement between roentgenologic disk degeneration, a positive myelogram, and neurologic disturbances. If the plain roentgenograms are negative and evidence of neurologic disturbances is lacking, it is fairly unlikely that myelographic examination will provide further information. If, on the other hand, there is evidence of both disk degeneration and clinical signs of nerve root involvement, the myelogram can be useful in establishing the level of involvement. The clinically estimated level does not always agree with the myelographic findings. Multiple contrast defects are remarkably common, which may explain the heterogeneous and indistinct clinical picture. It would seem that frequently several nerve roots are irritated simultaneously. Certainly it is impossible on the basis of the examinations reported here to define which of the contrast defects visible in the myelogram represents the active process. Under these circumstances there is no choice but to accept the idea of multiple disk ruptures.

TABLE 2
Non-operated cases with positive myelogram

Diary no.	Age	Sex	Duration of symptoms	Subjective symptoms in arms		Neurological examination			Electromyographic [illegible]	[illegible]	Myelographic [illegible] Nerve root [illegible]
				Right	Left	S[illegible]	R[illegible]	[illegible]			
0[illegible] 12 18	50	♂	2 months	C6		+				C5 C6	C6
00 03 31	58	♂	4 months	C8		+	+	+	+	C[illegible] C6 C6 C7	C6+C7 right
09 07 06	50	♂	7 months		+					C6 C7	C6 right
08 11 [illegible]	51	♂	10 months	C6+C7	C6+C7			–		C6 C7	C7 right
[illegible] 01 [illegible]	[illegible]	♂	5 years	C8	C6+C7+C8	+		+	+	C3 C4 C5 C6 C6 C7	C4 right+left C[illegible] right+left C6 right+left
0[illegible] 03 13	57	♂	5 years	C8			+		+	C5 C6 C7	C6+C8 right

TABLE 1
Operated Cases

Case	Age	Sex	Duration of symptoms	Subjective symptoms Right	Subjective symptoms Left	Neurological signs [illegible]	Neurological signs Reflexes	Neurological signs [illegible]	Electromyographic examination	Roentgenographic examination (Disk degeneration)	Myelographic examination (Narrowing, side)	Operation (Herniated disk)	Length of follow up (months after op)
18 05 08	40	♀	4 months	C6		+				C5 C6 C7	C7 right	C6 C7	12
18 06 20	41	♂	2 years	C6			+	+		C4 C5 C6	C5 right C6 right	C4 C5 C5 C6	9
08 01 11	51	♀	2 years	C6		+			C4 C6	C3 C4 C5 C6 C7	C5 right C6 right + left	C4 C5 C5 C6	8
01 07 23	58	♀	2½ years	+		+		+		C6 C7	C5 right + left C6 right + left C7 right + left	C4 C5 C5 C6 C6 C7	8
07 11 07	52	♀	1 years		C8		+	+		C3 C4 C5 C6 C7	C5 left C6 left	C4 C5 C5 C6	7
06 11 18	51	♀	6 years	C8						C5 C6 C7	C6 right + left C7 right + left	C5 C6 C6 C7	6
19 01 04	46	♀	11 years		C8				C8	C5 C6	C6 left	C5 C6	7



Fig 4
The surgical approach

SURGICAL TECHNIQUE

So far 7 of the patients with positive myelograms have been operated upon (Table 3) All patients were intubated and the operation performed in the supine position The operation consisted of an antero-lateral partial disk excision according to the technique which in Sweden has been introduced by Lindblom Olsson Hult The procedure is very simple Incision is made along the sternocleidomastoideus muscle Passing in front of the sternoclavicular muscle the carotid sheath is moved laterally and it is then easy to penetrate into the layer of loose connective tissue which follows the cource of the medial cervical fascia passing under the thyroid gland the trachea and the oesophagus to the deep fascia fascia praevertebralis (Fig 4) In this way the vertebrae and the ventrolateral aspects of the disks can be reached without any difficulty and without sharp dissection By moving the prevertebral muscle structures slightly to one side the disks become open to inspection The level of the disk to be operated is then determined by means of localizing roentgenograms Roentgenograms are taken with a needle inserted in

TABLE I
Operated cases

Diar.	Age	Sex	Duration of symptoms	Subjective symptoms in arms		Neurological examination			Electromyographic examination	Roentgen profile examination [illegible]	Myelographic examination Nerve root compression	Operation Resection of [illegible]	Length of follow-up in months after op.
				Right	Left	Sensation	Reflexes	Paresis					
18 05 04	40	♂	3 months	C6		+				C5 C6 C7	C7 right	C6 C7	12
18 06 2?	41	♀	2 years	C6			+	+		C4 C5 C6	C5 right C6 right	C4 C5 C5 C6	9
08 03 13	51	♂	2 years	C6		+			C4 C6	C3 C4 C5 C6 C7	C5 right C6 right+left	C4 C5 C5 C6	8
03 07 21	6	♂	2½ years	+		+		+		C6 C7	C5 right+left C6 right+left C7 right+left	C4 C5 C5 C6 C6 C7	8
07 11 07	52	♂	3 years		C8	—	+	+		C3 C4 C5 C6 C7	C5 left C6 left	C4 C5 C5 C6	3
06 11 18	53	♂	6 years	C8		—	-	—		C5 C6 C7	C6 right+left C7 right+left	C5 C6 C6 C7	6
13 01 04	46	♂	13 years		C6	—		—	C8	C5 C6	C6 left	C5 C6	3

RÉSUMÉ

Des malades souffrant de douleurs dans l'épaule et le bras alors que la mobilité de l'articulation de l'épaule était intacte et de douleurs rayonnant dans un ou plusieurs doigts ont été soumis à un examen clinique roentgenologique myélographique et discographique. Lorsque des troubles neurologiques ou une dégénération évidente du disque dans un ou plusieurs disques intervertébraux sont découverts, ils sont souvent accompagnés d'un myélogramme positif bien que si l'on se base sur l'examen clinique le niveau de la lésion ne corresponde pas toujours à celui établi par l'examen myélographique. Dans beaucoup de cas le myélogramme dévoile des compressions multiples des racines nerveuses qui doivent être considérées comme l'explication des difficultés rencontrées pour établir par l'examen clinique le niveau des vertèbres en cause. Apparemment plusieurs racines nerveuses peuvent être comprimées simultanément contrairement au tableau clinique usuel dans les cas des disques lombaires. L'irritation de racines nerveuses des disques cervicaux apparaît à un âge plus avancé que ce n'est le … les disques
lombaires. Étant donné que la fréquence de la dégé … du disq e
augmente avec l'âge on peut s'attendre à rencont … nération
multiple de disques et plusieurs racines nerveuse … es aux
aux différents

Dans un nombre de cas sélectionnés ou le m … tif cor
respondait aux trouvailles cliniques, une fenest … ale d
disque a été pratiquée. Les sujets étaient des … d a
leurs dans l'épaule et le bras depuis très longt … à le
à toute autre thérapie.

Au cours de l'opération le niveau de la lés
par une ponction discale et un examen disco
discale n'a pas été suivie d'ostéosynthèse cer
dats ont été bons.

ZUSAMMENFASS

Patienten die bei uneingeschränkter Sch
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Fingern … urden klinisch röntge
diskograp … rsucht. Wenn
genologisch … für eine De
mehreren Z … eischeiben g
einem positi … am begleite
meine Höhe de … ins nicht a

fundenen übereinstimmt. In vielen Fällen deckte das Myelogram vielfache Wurzelkompressionen auf, ein Umstand der die Schwierigkeiten *bei der klinischen Feststellung der genauen Höhe der Erkrankung zu* erklären vermag. Augenscheinlich können mehrere Nervenwurzeln gleichzeitig ergriffen sein, im Gegensatz zu dem gewöhnlichen klinischen Bilde in der Lendenwirbelsäule. Nervenwurzelreizung durch Halswirbelzwischenscheiben kommen in einem höheren Alter vor als dies in der Lendenwirbelsäule der Fall ist. Da die Häufigkeit der Diskusdegeneration mit höherem Alter zunimmt, ist mehrfache Scheibendegeneration und Ergriffensein von mehreren Nervenwurzeln in verschiedenen Höhen zu erwarten.

In einer ausgewählten Anzahl von Fällen, in denen ein positives Myelogram mit dem klinischen Befunde übereinstimmte, wurde eine anterolaterale Eröffnung der Scheibe ausgeführt. Die Operierten waren Patienten mit langdauernden Schulter-Armschmerzen, die jeder anderen Behandlung widerstanden hatten.

Während der Operation wurde die Höhe der Scheibenbeschädigung mittels Scheibenpunktion und Diskographie festgestellt. Der Diskuseröffnung wurde keine cervikale Osteosynthese hinzugefügt. Die unmittelbaren Ergebnisse waren gut.

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MYELOGRAPHY WITH PANTOPAQUE IN THE DIAGNOSIS OF CERVICAL DISK HERNIATION

By

H. Louis

The increasing tendency to treat disk herniation in the neck region by operative methods has placed greater demands on the roentgen diagnosis of the condition. Compared with the usually straightforward clinical picture of lumbar disk lesions, herniation of the cervical disks is associated with a rich variety of symptoms and is indistinguishable from a number of other conditions. Furthermore, the bony changes seen on examination of the cervical spine, namely disk degeneration and osteophyte formations, are only partly and irregularly related to the clinical picture. Before any operative procedure can be undertaken, therefore, careful assessment of the anatomical relations of the nerve roots must be made, and this can be done by means of myelography.

Myelography of the cervical spine may be carried out with the aid of negative contrast media, usually oxygen, or with opaque substances of the iodized oil type.

Oxygen myelography is a safe method, the contrast medium being rapidly absorbed and leading to no undesirable late reactions. The investigation may be unpleasant for the patient, and mild side-effects such as headache and slight pyrexia sometimes occur. In combination with tomography and correctly employed, the method gives better and more reliable results than myelography with iodized oil. Cervical disk lesions producing deformity of the anterior subarachnoid space are thus readily visualized, but the root sheaths are as a rule impossible to assess satisfactorily.

Oil myelography with Pantopaque provides a better, and often very good, idea of the state of the cervical root sheaths, but views vary greatly regarding the use of oily contrast media. Bull (1951) writes: "As a general rule Pantopaque is the contrast medium of choice", but Lindgren (1954) holds that this method is not as a rule justified

The divergences of these views is not entirely based on radiological considerations.

One important reason why the method is little used in Sweden is the physical and chemical properties of the substance and the consequent meningeal reaction recently described again by Bonte (1958).

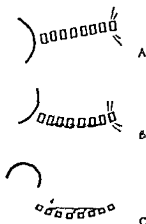


Fig. 1.

Schematic drawing. Position of the cervical spine a) during puncture of the subarachnoid space b) during injection of the contrast medium c) during exposure.

Pantopaque (ethyl iodophenyl undecylate) is a mixture of isomeric esters. It contains 30.5 % of iodine and has a specific weight of 1.26 at 20° C. Its coefficient of viscosity is 0.37 at 25° C. Theoretically it is absorbed very slowly, but removal of as much of the contrast medium as possible is recommended.

The substance is not a primary irritant and the investigation can therefore be carried out without discomfort to the patient. During the following days there may be slight reactions of the same type and degree as occur after oxygen myelography (meningism, pyrexia). It is noteworthy that residual Pantopaque has been found to produce late meningeal reactions in the form of chronic arachnitis, but the clinical significance of such late reactions is not fully established.

Owing to the demand for improved pre-operative morphological investigation and in the absence of other non-irritant contrast media *we have adopted the method but only in cases of possible involvement* of the cervical roots.

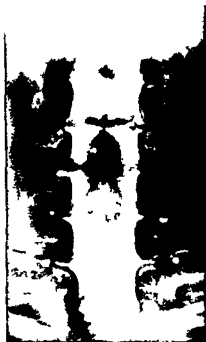


Fig. [illegible]
Frontal radiogram demonstrating small root cysts filled with the oil contrast medium

TECHNIQUE

Each myelography is preceded by standard radiographs of the cervical spine in frontal, lateral and oblique projections. Awareness of the existence of disk degeneration and the position and size of osteophytes is essential for the correct interpretation of the myelograms.

The patient is lightly premedicated and placed on his side on a tilt table, with the head end slightly lowered (fig. 1 a). Suboccipital puncture is carried out in this position, the needle being introduced parallel to the base of the skull (i.e. not into cisterna magna). When the tip of the needle has entered the subarachnoid space, the patient's head is raised slightly in order to bring the middle part of the cervical region to its lowest point (fig. 1 b). 7–10 ml of Pantopaque is now slowly injected, the exact amount depending on the size of the patient. The contrast medium will then collect in the middle part of the cervical canal. The needle is withdrawn and the patient is placed in the prone



a b

position with the chin slightly raised (fig 1 c) In this position the ex posures are made It is of the greatest importance that the position of the head is carefully watched or the contrast medium will pass up into the head and it will be difficult or even impossible to get it to return to the neck The position of the contrast medium in the canal may be adjusted by tilting the table

The patient is examined in prone and half prone (45°) positions Radiograms are taken with the beam in both vertical and horizontal directions The procedure is facilitated by screening but may like lumbar myelography using water soluble contrast media be performed without this aid

After the investigation the patient is allowed to sit up for about 5 minutes and is then placed prone in pronounced lumbar lordosis



Fig. 3 a–d

Normal case. Standard examination normal. Myelographs: a) frontal, b) lateral, c–d) oblique radiogram. The root sheaths normal. In the lateral view (b) slight protrusions of the disk between C 2–C 3 and C 5–C 6.

In this position as complete withdrawal as possible of the contrast medium can be achieved after lumbar puncture.

MORPHOLOGICAL CONSIDERATIONS

There are 8 cervical roots. Topographically this means that the first cervical root emerges between the occiput and the atlas, and that the 8th cervical root emerges above and the 8th below the 7th cervical vertebra. In the upper part of the cervical spine the nerve roots emerge at almost right angles to the medulla, but lie increasingly obliquely



a b

towards the lower part A nerve root can be compressed by only one disk however namely that lying at the level of the intervertebral foramen through which the nerve passes The root of C 7 is compressed by the disk between C 6 and C 7 etc

In assessing the myelogram note must be made of the state of the posterior surface of the vertebral body This is smooth and even at the level of the peduncles but has besides a slight prominence at the middle of the posterior surface with a shallow groove on each side These last named are important in assessing the profile view in myelography (See below)

It is still considered that the osteophytes that penetrate the intervertebral foramen from in front are localized to the uncovertebral joints (the neurocentral synovial cavities of Luschka) These joints are situated laterally on the vertebral bodies at the level of the intervertebral foramen in intimate relation to the nerve Abnormal strain due to narrowing of the disk will lead to reactive changes in these joints



c d

Fig. 4a–d

Disk protrusion. Standard examination revealed degeneration of the disk between C 6 and C 7 with osteophytes. Myelography a) frontal b) lateral c–d) oblique radiograms. On the lateral view (b →) a filling defect due to the disk protrusion can be seen. The root sheaths are not deformed.

consisting of periarticular swelling and subsequently the formation of osteophytes. The presence of these is best detected from the oblique radiograms of the vertebrae.

MORBID ANATOMICAL CONSIDERATIONS

Lesions of the disks may be classified as follows.

Bulging of the annulus fibrosus: disk protrusion. The annulus fibrosus is intact and protrudes as a result of approximation of the vertebrae. The loss in thickness of the disk is as a rule due to degeneration resulting from progressive diminution in the water content of the nucleus pulposus but may also be due to interspongious herniation of





a b

the nucleus Protrusion is often total that is the entire disk bulges backwards but partial protrusion may also occur Marginal osteophytes are formed secondarily principally in the uncovertebral joints

Herniation of the nucleus pulposus In such cases the annulus fibrosus is torn (except when the nucleus herniates into the spongiosa) The hernia may be medial or lateral A hernia that is very lateral or situated in the intervertebral foramen does not cause pressure on the dural sac Marginal osteophytes develop secondarily chiefly in the uncovertebral joints

Spondylosis deformans Typical of this state is the multiplicity of osteophytes on the vertebral borders and of intervertebral disks showing some loss of thickness

According to McRae (1956) a combination of the above changes is the rule and not the exception among middle aged and elderly persons



Fig. 5 a–d

Disk herniation. Standard examination normal. Myelography a) frontal b) lateral c, d) oblique radiograms. On the left side the root pouch of C 7 is shortened and compressed (a →). The oblique radiogram reveals more clearly a defect in close relation to the root pouch (d →). Lateral view (b) normal.

RADIODIAGNOSTIC CONSIDERATIONS

For a correct assessment of the myelograms it is essential that the injected oil collects into a continuous column. If this becomes fragmented, it becomes extremely difficult to form a reliable opinion. In such cases the contrast medium may be reassembled in the lumbar region and then transferred to the cervical region again.

The great absorbancy of Pantopaque, in other words its great roentgen density, carries with it the disadvantage that impressions in the contrast medium need only to be coated with a thin layer of oil in order to be completely concealed. A variety of projections including oblique



a b

views are therefore necessary and in selecting the exposure values attention must be paid to the amount of contrast medium which should be no more than that a continuous column is obtained

The high viscosity of the contrast medium and its inability to mix with the cerebrospinal fluid are disadvantages as the substance passes with difficulty into small spaces and through fine canals As can be seen from fig 2 however Pantopaque can provide filling out of root cysts that are connected with the root sheaths by only fine pedicles The physical properties of Pantopaque are such that care must be excercised in assessing partially filled root pouches however

The normal myelogram (fig 3) The normal myelogram of the cervical region is characterized by the total or almost total absence of disk protrusions in the profile view If the column of contrast medium is thin any barely discernible protrusions can also be detected on the frontal view as strip like translucent areas at the level of the disks The protrusions correspond to the degree of lordosis In hyperextension



c

Fig. 3 a–c

Disk herniation. Standard examination: disk degeneration between C. 5 and C. 6 with reduced intervertebral space and small osteophytes in the corresponding right unco-vertebral joint. Myelographs: a) frontal, b) lateral, c) oblique radiograms. A large filling defect is seen on the right side (→). The root pouch of C. 7 is not filled (a, c). Lateral view: a very slight protrusion of the disk C. 5–C. 6.—The patient has been successfully operated upon.

a certain measure of protrusion occurs naturally and at the same time the vertebral arches approximate and the ligamenta flava become relaxed. As a result slight impressions may appear laterally and posteriorly. A normal cervical myelogram shows filling out of all root pouches. These are shorter and broader than those in the lumbar region. The breadths may vary but are symmetrical. Both anterior and posterior nerve roots may often be distinguished as long, narrow defects.

The myelogram in disk protrusion (fig. 4). Depending on the degree of protrusion and the thickness of the oil layer, a disk protrusion appears on the frontal myelogram as a ribbon-like thinning of the contrast



a b

medium at the level of the affected disk in question If there is a marked degree of protrusion the root pouches may be deformed or even nipped off In the profile view a concavity in the column of contrast medium can be seen at the level of the protruding disk If the lesion is to be detectable in the profile view it is a condition that the whole of the posterior border of the disk be protruding in the lateral view partial protrusion of the disk is totally masked by the contrast medium in the shallow grooves on the posterior surface of the vertebral bodies Oblique views are essential in the assessment of partial disk protrusion

Myelogram in disk herniation (fig 5 and 6) The frontal myelogram in this state typically shows a unilateral defect in the column of contrast medium with deformity or total crushing of the adjacent root sheath More lateral herniation affects only the root pouch The profile view may be negative as the disk prolapse may be completely concealed by contrast medium lying alongside the disk hernia or in one of the lateral shallow grooves In such cases oblique projections supply the necessary information



Fig. [illegible] a–d

Standard examination (a) large osteophytes narrowing the intervertebral foramen C 6–C 7 (→). Myelography (b) frontal (c) lateral (d) oblique radiograms. The right pouch of C 7 (→) is shortened with a small filling defect (b, d) due to the osteophytes. No protrusion of the corresponding disk visible on the lateral view (c).

The myelogram in spondylosis deformans (fig. 7). The myelogram varies according to the size and site of the osteophytes and the presence and degree of reduced intervertebral interval. There may be signs of disk protrusion as described above or of some greater or lesser degree of deformity or compression of root pouches. In the event of the latter some direct anatomical relation between the position of the osteophytes and the filling defects may be demonstrable.

DISCUSSION

It is clear that in straightforward cases it is possible with the aid of myelography to distinguish between disk protrusion, disk prolapse and changes due to spondylosis deformans. In elderly patients, however, in whom a combination of these conditions is commonly found

the differential diagnosis may be uncertain or impossible. Compression of a nerve root may be caused by disk prolapse, partial protrusion or osteophytes. Disk prolapse, which is the most important of these lesions from the operative point of view, is easiest to establish in those cases in which the thickness of the disk is unchanged and osteophytes have not yet developed. It is important to remember that disk herniation situated extremely laterally need not necessarily affect the dural sac or root sheath: negative myelographic findings do not exclude disk prolapse.

Our series so far includes 45 patients examined since January 1st 1958. In a few cases we have seen side-effects in the form of slight pyrexia and transient meningism. The observation period is still too short to express an opinion concerning late complications, but it has been possible to remove about 90 % of the injected contrast medium in practically all cases.

Myelography with Pantopaque is extremely valuable in assessing the state of the spinal nerve roots in the cervical region. Having regard to the divergent views on late reactions and their clinical significance the indications for the investigation must be limited, and it should be carried out only in cases in which involvement of the nerve roots is suspected and in which operation is contemplated.

SUMMARY

An account is given of the technique of cervical myelography using Pantopaque. The value of the method in investigating the state of the cervical nerve roots is emphasized. Owing to the possible risk of late complications, however, the procedure should only be carried out in cases in which involvement of the nerve roots is suspected and in which operation is contemplated.

RÉSUMÉ

Il est rendu compte de la technique de la myélographie cervicale utilisant le pantopaque. La valeur de la méthode pour examiner l'état des racines nerveuses cervicales est soulignée. Toutefois, en raison du risque de complications tardives, le procédé ne doit être appliqué que dans les cas où l'on soupçonne que les racines nerveuses sont en cause et où l'on envisage de procéder à une opération.

ZUSAMMENFASSUNG

Es wird über die Technik der cervikalen Myelographie mit Pantopaque berichtet. Der Wert der Methode zur Untersuchung des Zustandes der cervikalen Nervenwurzeln wird hervorgehoben. Wegen der möglichen Gefahr später Komplikationen sollte das Verfahren jedoch nur in Fällen ausgeführt werden, in denen eine Erkrankung der Nervenwurzeln vermutet und eine Operation erwogen wird.

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DOES GRANULATION TISSUE IN THE INTERVERTEBRAL DISC PROVOKE LOW BACK PAIN?

By

ULF FERNSTRÖM and IAN GOLDIE
Uddevalla

It is difficult to ascribe the origin of low back pain to any specific feature. Factors involved are muscles, ligaments, joints and intervertebral discs which all play a part in the production of pain. Some consternation arose when Key (1945) pronounced that lesions of the intervertebral disc were the most common cause of low back pain. The discussion that followed the publication of his paper in 1945 showed that neither neurosurgeons nor orthopaedic surgeons were apt to accept Key's ideas. But further investigations in this matter have led to a wider recognition of the importance of the intervertebral disc. The work carried out by Lindblom (1951), Hirsch (1948, 1951), Hirsch & Schajowicz (1952), Wiberg (1949) and Fernström (1956, 1957) indicates with great accuracy that in most cases of low back pain the intervertebral disc is the cause.

The question then arises what the painprovoking agent in the intervertebral disc is. As early as in 1850 Luschka demonstrated a nerve, the sinuvertebral nerve, which was formed by a cerebrospinal and a sympathetic root. It gives off branches to ligaments, vessels and surfaces of vertebral bodies. These observations were in part confirmed by Hovelacque (1925). The sensory innervation of the posterior part of the spinal column is believed to be furnished by the sinuvertebral nerve (Steindler 1940, 1947) and low back pain is supposed to be caused by involvement of this nerve (Falconer et al. 1948). Whether this nerve enters the intervertebral disc is, however, a matter of controversy. Wiberg (1949) has been able to trace the nerve to the ligamentous coverings of the disc and so has also Roofe (1940), but on studying the microphotographs the latter has published, it appears as if the sinuvertebral nerve enters into the annulus fibrosus of the disc. Stilwell

(1956) has found the nerve supply to be confined to a thin lamina of loose connective tissue at the surface of the disc. Tsukada (1938) and Ehrenhaft (1943) maintain from their own observations that the annulus fibrosus contains nerve fibres. These investigations have however been strongly criticized. Much evidence points to the fact that the annulus fibrosus is devoid of nervous tissue (Jung and Brunschwig 1932, Pedersen et al. 1956) and the concept is that pain arises from the ligamentous covering of the disc.

In 1952 Hirsch & Schajowicz, who had made an extensive investigation of anatomical, pathological and physiological conditions of the intervertebral disc, introduced an interesting idea. He suggested that large rifts in the disc were healed by invasion of reparative tissue from without. An observation of the same kind had been made by Lindblom and Hultquist in 1950. The tissue is highly vascular and regarded as granulation tissue and Hirsch believed that this might be an important pathological basis for low back pain. The pain is believed to originate from nerves accompanying the blood vessels. Hirsch could not, however, demonstrate any such nerves.

This trend of thought was taken up by us and we examined 122 operated discs (Goldie 1957) aiming at the discovery of possible granulation tissue and consequently nerve fibres. In 40 discs granulation tissue was observed but no nerves could be identified. Though objections may be raised that a technique has not yet been employed sensitive enough to detect nerve fibres in granulation tissue, it cannot be regarded as too brave to refute the theory of low back pain arising from nerves in granulation tissue invading the disc.

TABLE

Correlation of granulation tissue to production of pain in intervertebral discs

Pain production	Granulation tissue present	Granulation tissue not present
Palpation of surface of disc	3	3
Curettage	10	64
Palpation and curettage	18	21
No pain	9	41
Total	40	1 9 — 169

Another reason for doubt regarding this theory are the observations we have made at operation in cases of low back pain. Wiberg (1949)

noted that pain could be elicited by touching the surface of the disc In cases where he touched the surface of the vertebral body facing the disc with an elevator after having removed the disc prolapse he could produce no pain He does not mention anything about production of pain whilst working with the instrument in the disc cavity proper We have also found pain to be produced when touching the disc surface But we have also been able to confirm an observation made by Lindemann and Kuhlendahl (1953) When inserting the conchotome into the cavity we like the abovementioned authors have been able to provoke pain while manipulating the instrument in order to extirpate disc tissue The patient (operated in local anesthesia) has immediately recognised the pain he has experienced On touching the cartilaginous plate of the vertebral body no pain has been elicited The same observations were made by Key in 1945

An interesting feature is to find out whether there is any correlation between the existence of granulation tissue and the production of pain in discs operated on At operation in local anesthesia pain has been registered when the surface of the disc has been touched and the cavity curetted The extracted disc has been microscopically examined for granulation tissue 169 discs have been examined and in 40 of these granulation tissue has been observed The table shows the correlation of produced pain to existence of granulation tissue in discs

From the table it becomes evident that in the majority of cases (88) where pain has been produced no granulation tissue has been observed Another interesting feature is the great number of cases with pain produced by curettage This favours the conception of Lindemann Kuhlendahl and Key It is however surprising that not more patients have felt pain at palpation of the surface of the disc We have not been able to find a plausible explanation of this

It has become evident that the origin of low back pain is still difficult to ascribe to one special factor No doubt the intervertebral disc holds a leading position but we have so far not been able to point to any specific structure in the disc The invading granulation tissue as a painprovoking agent does not give any satisfying evidence and under these circumstances the theories of the sinuvertebral nerve with its branching are more acceptable

SUMMARY

Pain has been elicited by instrumental provocation in 169 lumbar discs The disc material has been microscopically examined with the

purpose of investigating the presence of granulation tissue It was thereby noted that pain could be provoked from discs whether granulation tissue was present or not This has led us to believe that granulation tissue in ruptured discs cannot be regarded as the painprovoking agent in low back pain

RESUME

La douleur a ete obtenue par provocation instrumentale dans 169 disques lombaires Des prelevements de disques ont ete examines au microscope dans le but de deceler la presence de tissu de granulation Il a ete observe que la douleur pouvait etre provoquee dans ces disques qu il y ait du tissu de granulation ou non Cela nous a amenes a croire que les tissus de granulation dans les ruptures de disques ne peuvent pas etre consideres comme l agent provocateur de douleurs dans les cas ou il y a des douleurs dans la partie inferieure du dos

ZUSAMMENFASSUNG

Schmerzen wurden mittels instrumenteller Reize bei 169 lumbalen Zwischenwirbelscheiben hervorgerufen Das Scheibenmaterial wurde mikroskopisch mit der Absicht die Gegenwart von Granulationsgewebe festzustellen untersucht Es wurde dabei bemerkt dass Schmerzen sowohl bei Scheiben mit als auch ohne Granulationsgewebe hervorgerufen werden konnten Diese Tatsache fuhrte dazu dass wir annehmen dass das Granulationsgewebe der gesprengten Scheibe nicht die Ursache der Schmerzen sein kann

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FROM THE ORTHOPAEDIC CLINIC, GOTHENBURG
(HEAD: PROFESSOR ERIK SEVERIN †)

CONGENITAL MANUS VARA

By

GUNNAR LUNDHOLM

The congenital defect of the radius produces a typical deformity of the hand: manus vara. Sometimes the name club hand is also used. Aplasia of the radius with typical deformity of the hand (*Petit*) was described as early as 1733. In 1924 *Kato* stated that he had found 250 cases in the literature and also reported 3 of his own cases. Later a number of publications appeared about this malformation (*Davidsson, Goldenberg, Heikel, Riordan, Starr* and others). In *Birch-Jensen*'s study from Denmark of congenital deformities of the upper extremities (1949) defects of the radius are stated to have an incidence of 1 in 30 000 births or throughout the whole population 1 in 55 000. A total absence of the radius occurred in 32 of *Birch-Jensen*'s 73 cases with defects of the radius. *Heikel* (1959) reviewed 424 previously published cases: total aplasia of the radius was found in 300 of these including 151 bilateral cases, while a further 31 had total aplasia of the radius on one side and on the other side a partial aplasia or hypoplasia of the radius. Amongst *Heikel*'s 47 personal cases there was a considerably lower incidence of total aplasia. Aplasia of the radius can therefore be considered unusual although it is not exactly a rarity.

At the Orthopaedic Clinic in Gothenburg three cases with aplasia of the radius have been treated in recent years.

CASE HISTORY

Case 1. A. E. v. B. L., born 13.1.1954, appeared for the first time at the Orthopaedic Clinic at Gothenburg in February 1954 owing to malformation of the arm. He was the youngest of nine children in a family with no known malformation or hereditary disease. The two arms were obviously short, especially the forearm. The hands were severely bent volarly and radially and both thumbs turned inward. No radius could be observed on the X-ray. The mother was instructed to

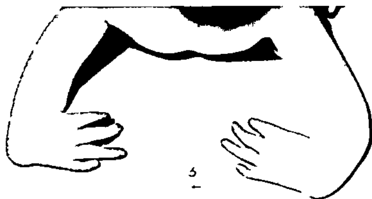


Fig 1
Case 1 Boy born 13/1 1954 Picture in April 1956 before treatment



Fig 2

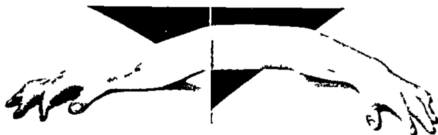


Fig 3 *Fig 4*

Figs 2, 3 and 4 Case 1 after corrections and operations

Fig 3 Lateral picture right hand *Fig 4* Lateral picture left hand


Fig 5


Fig 6

Figs 5 and 6 X ray in April 1956 forearms Case 1 The radius is absent bilaterally


Fig 7

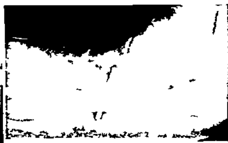

Fig 8

Fig 7 X ray in January 1957 left forearm Case 1 The hand was reduced openly and the carpus fixed to the ulna with a Kirschner wire

Fig 8 X ray in June 1957 left forearm Case 1 The transplanted end of fibula is fixed to the ulna with two crossed Kirschner wires

stretch the boy s hands in the corrective direction and also to try and persuade him to use the hands actively In April 1956 at a control examination his ability to grip was relatively good and he could also feed him elf The deformity of the hands was unchanged (Fig 1) Pas ively the deformity could only be partially corrected B th passively and actively a m derate limitation of movement was present in the joints of the fingers Active flexion was found in all fingers but there was no e ident extensi n Treatment was initiated with c rrection under narco is and with plaster in stage o a to prep re for urgical int rvention On examinati n f the bl d thr mb cyt penia as ertained (4 000 and 24 000 thr mboc te per mm^3 in two ca es) but no anaemia was present an l bleeding an l c agul tion times were n rmal Owing to the thrombocyt penia the perati n was p tp on d for a time

When aged 3 (30 1 1957) the patient underwent pen r duction of the ulna to-



Fig 9



Fig 10

Fig 9 X ray in August 1958 left forearm Case 1 The fibula transplant has well healed with the ulna which has grown

Fig 10 X ray in April 1959 left forearm Case 1 The fibula transplant seems on the picture to have increased in length and an epiphysis nucleus has emerged The ulna has grown both in width and length

wards the carpus + fixation with kirscher wire according to Riordan (Fig 7) Three months later the second stage of the operation was performed transplantation of the upper part of the right fibula to the ulna (Fig 8) At the operation the epiphysis of the fibula was also taken and the fibula transplant was inserted into the ulna and fixed with two kirschner wires crosswise through the transplant and the ulna The post operative course was uneventful

On the 9th of May 1958 the first operation on the right hand was performed Before the operation he had 54 000 thrombocytes per mm³ otherwise the blood tests were normal Some hours after the operation a quickly passing rash resembling rubeola appeared on the body The rash was considered to the an allergic symptom Three days later there was nose bleeding with suddenly considerable blood vomiting shock occurred Blood transfusion and treatment with adrenocortical steroids were given immediately The condition improved rapidly The thrombocyte count which on bleeding was 9 000/mm³ rose as high as 190 000/mm³ but later dropped again to about 50 000/mm³ when the steroid dose was reduced

On 29/8 1958 the second stage of the operation was performed on the right hand without complications Then the patient was given prophylactic treatment with adrenocortical steroids (All operations were performed by Professor F Severin)

At the last check up in April 1959 —at 5 years of age—the boy had good function in both hands with active flexion and extension ability in all the fingers although there was a certain limitation of movement in the joints of the fingers actively and passively approximately as before the operation The cosmetic result was good (Figs 2 3 and 4) X ray examination of the left hand showed a well healed transplant which on the X ray had increased in length but whether this is true growth or progressive ossification of the epiphysis cannot be determined An epiphyseal nucleus had emerged in the transplant The ulna had grown in length and breadth The hand is situated in position to the middle of the end of the ulna (Fig 10)

Case 2 A boy B S born 15/3 1958 was shown at the Orthopaedic Clinic as a newborn There was no known malformation or blood disease in the family where

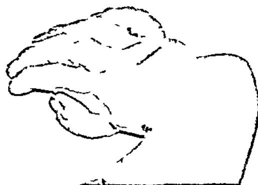


Fig 11
Case 2 Boy born 15/3 1958 Photograph of right arm in March 1958



Fig 12
Case 3 Woman born 4/10 1935 Photograph in September 1959

he was the second of two children His right hand was severely bent volarly and radially The thumb which was rudimentary and connected only by a thin stem lacked function (Fig 11) Active power of movement was found in the remaining fingers The right forearm was shortened The X ray examination of the right fore arm showed that the radius and first metacarpal were missing The base phalanx of the thumb was very small There were no other skeletal malformations The blood values were normal apart from a temporary thrombocytopenia Later examination repeatedly demonstrated a normal thrombocyte count The thumb became gangrenous owing to the fact that its thin soft tissue shaft became twisted in one night The thumb was removed Then treatment was initiated with corrections and plaster by tage and the same operative interventions were performed as reported above in case 1

Case 3 A woman E.J born 4/10 1935 According to her own information she wa

brought at the age of 2-3 to the Orthopaedic Clinic in Gothenburg for her malformed hands No measures were undertaken The record cannot be found however and her information is vague Possibly the patient was instead examined elsewhere In May 1959 she was examined at the Orthopaedic Clinic There was no known malformation in the family In 1955 she underwent a colostomy for congenital malformation of the rectum

Arms Pronounced congenital malformations Her right upper arm was of normal length but the left upper arm was very short (10 cm) Her forearms were short (about 14 cm) Her hands showed a severe varus position and the thumbs were missing (Fig 12) There was considerable limitation of movement in the elbow joints and stiffness in the wrist joints Mobility in the fingers was poor The hand function was astonishingly good but the strength was poor She could fasten buttons and grip objects She fed and took care of herself—For the time being she is being trained as a photographer at the Anggården craft schools

The blood tests showed no anaemia or thrombocytopenia

The X ray examination of the forearms showed that the radius was completely absent and also some of the carpal bones and the first metacarpal bone

No treatment of the patient s malformations is planned

DISCUSSION

In congenital aplasia of the radius the hand has a varus position The forearm is shortened and sometimes short upper arms are also seen so that one may even speak of phocomelus which *Hill* has described In one of my cases a very short upper arm occurred on one side In 50 % the malformation is bilateral and if unilateral the right side is much more commonly involved than the left side (*Riordan* and *Heikel*) Other skeletal malformations are often present Thus the first metacarpal bone and a number of carpal bones may also be missing as well as the thumb which sometimes may also be rudimentary and useless The muscles of the hand and arms may be defective or completely absent Aplasia of the radius is found in combination with malformations of varying types often serious defects so that the prognosis is often poor but those who survive childhood probably have possibilities of a fairly normal life (*Birch Jensen*) In a number of cases with aplasia of the radius blood changes occur such as Fanconi s syndrome and thrombocytopenia (*Riordan* and *Gross* etc) In two of the author s cases thrombocytopenia appeared It was possible to carry out surgical treatment in case 1 in spite of a pronounced thrombocytopenia With respect to the combination of aplasia of the radius and thrombocytopenia the reader is referred to an article to be published in Acta Pediatrica (*Nilsson* and *Lundholm*)

The etiology of aplasia of the radius is unknown The malformation

may be inherited dominantly and apparently also recessively but in the majority of the cases no hereditary character appears (*Birch Jensen*) In none of the author s three cases was a malformation known to be present in the respective families

TREATMENT

Several different methods of treatment for congenital manus vara have been described The malformation must be corrected surgically because corrections plaster and splints do not in the long run produce lasting results However as a rule conservative treatment precedes the surgical interventions

Lange suggests conservative treatment up to three years of age when soft tissue operations with tendon lengthening are performed If the surgeon is unsuccessful in obtaining a good position of the hand a shortening osteotomy is later performed on the ulna Various suggestions have been made for maintaining the hand in position *Lange* considers that the final operation should not be performed until 14 years of age According to *Bardenheuer* the ulna is divided distally and the carpal bones are placed between the two ends of bone *Reyerson* placed the rear part of the ulna in the radius position A tibial transplant is used according to *Albee* s method which shows good results primarily but when the bone transplant does not progress with the growth of the ulna recurrence may occur In order to avoid this a resection of the epiphysis of the ulna can be performed but this results then in diminished growth of the already short forearm *Campbell* makes a hole in the carpus and implants the end of the ulna in this In *Gocht* s procedure the distal end of the ulna is wedged centrally into the carpal bones The hand may also be fixed to the ulna with marrow nailing according to *Stracker* s proposal

Riordan describes a plan of treatment in which he like *Starr* employs the proximal part of the fibula with its epiphysis placing them in the position of the radius *Riordan* s method distinguishes itself from *Starr* s in that in the first stage of the operation the carpal bones are placed in a normal position for the distal end of the ulna of open reduction and are possibly fixed there by Kirschner wire The operation is performed through an incision from both ulnar and radial aspects With a curvature of the ulna an osteotomy is performed later if this should prove necessary In a later stage of the operation the upper part of the fibula is placed to support the carpal bones radially and the in

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more favourable condition. The operative interventions must not be delayed therefore but they must be carried out quickly when the best possible position has been achieved with conservative treatment. Before the operation one must make certain that the patient has no other complaint which might create difficulties for the operation. The possibility of pathological blood changes ought then especially to be kept in mind. As a support for the carpal bones instead of the radius the upper part of the fibula with its epiphysis is recommended.

SUMMARY

An account is given of three cases with congenital aplasia of the radius, two children and a woman. Two were bilateral, two were combined with thrombocytopenia. The etiology of this unusual complaint is unknown.

In aplasia of the radius the hand is in the varus position—manus vara. Various methods of correcting the malposition are studied. The treatment of a child with bilateral changes obtained good results from corrections, open reduction and finally transplantation of the upper part of the fibula as a support for the carpus on the radial aspect. The treatment of a child with unilateral change has commenced.

RÉSUMÉ

Compte rendu de trois cas d'aplasie congénitale du radius: deux enfants et une femme. Les deux étaient bilatérales et deux étaient combinées avec une trombocytopénie. L'étiologie de ces cas exceptionnels est inconnue.

Dans l'aplasie du radius la main se trouve en position varus —manus vara. Différentes méthodes de correction de la déviation sont examinées. Un enfant ayant des modifications bilatérales a été traité avec de bons résultats par des corrections, une reposition ouverte et finalement la transplantation de la partie supérieure de la fibule comme support pour le carpe du côté radial. Le traitement d'un enfant ayant une déformation unilatérale a été entrepris.

ZUSAMMENFASSUNG

Bericht über drei Fälle mit kongenitaler Radiusaplasie, zwei Kinder und eine Frau. Zwei Fälle waren doppelseitig und zwei waren kom-

biniert mit Thrombocytopenie Die Athiologie dieser ungewohnlichen Erkrankung ist unbekannt

Bei der Radiusaplasie steht die Hand in Varusstellung – manus vara Die verschiedenen Methoden fur die Korrektion der Fehlstellung werden durchbesprochen Ein Kind mit doppelseitigen Veranderungen wurde mit gutem Resultat mittels offener Reposition und folgender Transplantation des proximalen Fibula anteiles zur Stutze der Hand wurzel auf der Radialseite behandelt Die Behandlung eines Kindes mit einseitiger Veranderungen wurde in Angriff genommen

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FROM THE ORTHOPAEDIC AMBULATORIUM AND CLINIC AALBORG
(HEAD P LUTKEN DR MED)

ARTHROPATHIA DIABETICA

By

A PETERSEN

Following the introduction of insulin treatment late diabetic complications were seen to an increasing degree in the form of neuropathies retinopathies and nephropathies but in addition to these arthropathies have emerged during the last 10–15 years the first collected data on the latter disease came in 1947 when *Bailey & Root* announced some cases

These arthropathies are however very rare in all 89 cases have been described in the world literature available to me and up to the end of 1958 as far as I know no Danish case had been published

At the Orthopaedic Ambulatorium Aalborg we gave treatment to 4 cases in 1958 one of which had previously been treated at the Orthopaedic Hospital Aarhus and later continued to have treatment there this case is consequently not included in this study but the following account is given of the other 3

Male I O aged 30 years N 25372

The patient has had diabetes from the age of 10 but there is no other case of diabetes in the family A brother is said to have suffered from a metabolic disease but information could not be obtained about its type

Insulin of varying kind had been administered since 1938 and now the patient is given daily 10 units of insulin Leo + 4 units of insulin Leo retard in the morning and 6 units of insulin Leo retard in the evening

It is difficult to keep his diabetes balanced and the patient has repeatedl been admitted to different hospitals both in Denmark and Norway where he ha had work for some years until in 1954 he had to give up his work owing to his diabetes in which complications have now arisen with nephropathia diabetes and retinopathia diabetes

Read before the Orthopaedic Association 29 11 58 in somewhat altered format

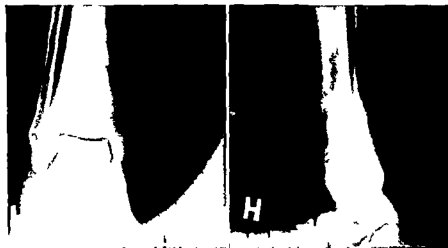


Fig 1
The healed fracture

In 1954 he was given an invalid pension

In the summer of 1957 the patient fell from his autocycle and struck the right crus and foot the lowest part of the right crus and foot joint became swollen and discoloured The disease was regarded as a severe sprain and the patient rested at home for 14 days before he was admitted to hospital

The X ray showed nothing definite on admittance and it was not until 3 weeks later that a transverse fracture was found through the lowest part of the right tibia proceeding down into the ankle joint The patient had splints for 6 weeks after which the fracture was healed (Fig 1)

6/3–29/3 1958 i e ¾ year afterwards the patient was again admitted owing to severe swelling of the right ankle joint and then those findings were made which led to the patient s removal to the Orthopaedic Ambulatorium Aalborg

On examination here the right ankle joint was found to be severely swollen the right foot to be subluxated in the varus position so that the patient walked on the lateral edge of the foot but without admitting pain (Figs 2 and 3) There was good pulsation in the dorsal artery of the right foot but sensibility was considerably reduced or completely absent from the right knee to the toes

Apart from this there were no neurological symptoms especially no sign of neurolues or syringomyelia

WR — GR — SR 80 mm/1 hour urine + alb EKG nothing especially abnormal

The X ray showed right foot subluxated medially The articular surfaces of both the tibia and fibula and also the trochlea tali were destroyed and surrounded by a sclerotic zone while the backward part of the talus showed a very irregular upper surface Around the whole of the ankle joint countless larger and smaller bone fragments could be seen ranging in size from rice grains to peas In addition calcification was observed in the joint capsule indicating regenerative changes (Fig 4)





Fig 2 Fig 3

Fig 2
The swollen foot in varus position

Fig 3
The swollen foot from the medial side

Fem F C., aged 62 N 96712

The patient has had diabetes from the age of 50 and receives now 14 units of insulin daily She has been admitted to hospital 7 times for her diabetes and at the last admittance in 1953 retinopathia diabetes was ascertained From the age of 20 the patient has suffered from varicose veins and these have become worse of recent years and cause some difficult

In the middle of July 1958 the patient fell and twisted the left foot she was given treatment at home but since the swelling did not diminish the patient was taken to the surgical ambulatorium 5 weeks after the accident The patient was X r yed here and it was thought that a fracture of the mall med sin was involved but the patient was sent home with a supporting elasticbandage and without other treatment

On the 3/10 58 we saw the patient at the Orthopaedic Ambulatorium Aalborg on examination the left foot and the ankle joint were found to be severely swollen with the foot standing in the varus position and with considerable lateral movement in the left talocrural joint The right foot was somewhat swollen corresponding with the dorsum of the foot (Fig 5)

There was good pulsation in the dorsal artery of the foot in both feet varicose veins in both legs and some edema.

In the right leg sensibility was much reduced from the knee to the toes in the left leg from 10 cm below the knee to the toes

The X ray showed destruction surrounded by sclerosis in the left talocrural joint Chopart s joint and Li f anc s joint and also in the right foot in Lisfranc s joint with destruction of the b e f th m tatarsal bones All the destroyed joints were urr unded by larger nd maller bone fragments. (Figs 6 and



Fig 4
X ray of ankle joint in pat no 1

Fem A DJ aged 65 N 92953

The patient has had diabetes for about 15 years she recalls only that it was ascertained during the climacterium She now receives 10 units of insulin mane

In 1957 she was admitted to hospital for her diabetes and for arthrosis gen sin

Besides the arthrosis gen sin a fragment resembling a fracture was discovered in the X ray at the edge of the right tibial condyle The check picture 26/6/57 showed this fragment to be dislocated distally and medially and then subluxation was found in the right knee with some varus position There were no signs of tuberculosis of the right knee

The patient came for examination to the Orthopaedic Ambulatorium Aalborg 14/8/1957 and the examination showed right knee severely swollen measuring in circumference + 4½ cm of the right knee which is in a varus position such that the right leg s axis falls 2 cm outside the 5th toe

Flexion extension is 90 /180 + evalutation of the patella + lateral shifting especially medially no drawer symptom no varicose veins of the right femur

The patient was issued with a supporting frame knee capsule

On the 10/10/1958 a check examination was made of the patient who had been called to the hospital as the fracture diagnosis was not certain

The patient then stated that from the 9/4 59 she was lying in hospital under treatment for a pertrochanteric fracture of the right femur that bed rest was the treatment and the fracture was then declared to be healed

The condition of the right knee was unchanged but the flexion extension was then only 150/180

The 10/10 X ray showed right knee The bone fragment lay as before but there was now seen an irregular defect at the site of the fragment in the medial tibial condyle. Moreover an initial defect was seen in the lateral femoral condyle and in front of this 2 fragments the size of rice grains



Fig 5
Phot graph of pat no 2 s legs and feet.

We constantly f ll w this patient in order to b erve the devel pment since we believe th t it is a questi n of n arthr pathia diabetica

Arthropathia diabetica was first described by *Bailey & Root* who wrote in 1942 about "Neuropathic joint lesions in diabetis mellitus (1) and again in 1947 described the disease (2) Later and particularly from the American and English side a number of articles were pub lished about arthropathia diabetica so that in all 89 cases have now been described

The largest series describing the disease is to be found in a study by *Miller & Lichtmann* from the Joslin clinic here 17 cases have been collected over a 5 year period 1950–1955 (7) from a total of 20 000 diabetics

On the Scandinavian side *J Muri* (3) described in 1949 a case of arthropathia diabetica and *Professor Folke Knudsen* (10) in 1951 re ported 4 cases from the University Hospital Radiological Clinic in Upsala

No case has so far been published in Denmark The majority of authors regard the diabetic arthropathia as belonging to the neuro pathies while individual authors constantly maintain that it is due to an infection The fact that biopsy in the joint capsules in the affected joints undertaken and described by several authors does not show inflammation reaction in these joints rules against the latter theory however In several cases there was either in the post mortem section



Fig. 6
X-ray of pat. no. 2

fat degeneration of or lack of myeline sheaths in the nerves corresponding to the extremity involved, especially in the nerves of the leg. Moreover, in 1917 *Eloesser* described some experiments on cats in which by severing the dorsal nerve roots he produced asensibility in the extremities and afterward produced fractures of these extremities; in a number of the cases joint diseases (Charcot's joint) arose which fully recalled those seen in arthropathia diabetica.

Almost all authors are agreed that the disease occurs in diabetics who have suffered from their diabetes more than 10 years, and owing to poor regulation of their diabetes have neuropathies, retinopathies or nephropathies and also by way of initial onset incurred a trauma of the affected joint of varying degree; often this trauma was not noticed by the patient owing to the absent or much reduced sensibility of the extremity.

Arthropathia diabetica is an irremediable disease and even with good regulation of the diabetes it is in the majority of cases progressive, although at a slow rate.

The initial symptoms are swelling of the affected joint or joints, often with subluxation of the joint, especially if the joint attacked is the talocrural joint; sensibility is also much reduced or completely absent over varying areas of the affected extremity, which means that the patient can walk on the affected joints without pain, thus aggravating disease by putting weight on the joints, often in poor position.

Radiologically destruction of the affected bone or bones is found with sclerosis round about and accumulation of bone fragments vary-



Fig. [illegible]
X-ray of pat. no. 2's forefeet

ing in size around the affected joint, with also occasionally some calcification of the joint capsule and soft tissues around the joints indicating regeneration.

The differential diagnosis with respect to corresponding joint affections with lues, especially in tabes dorsalis, should not cause difficulty since W.R. in blood and spinal fluid will give the diagnosis in these cases. Syringomyelitis may equally produce corresponding joint changes, but while diabetic arthropathia is localized in almost all cases to the lower extremities, syringomyelitis is localized to the upper extremity, just as in syringomyelitis other typical neurological symptoms are found.

The treatment of arthropathia diabetica is limited to the equipping of the patient with suitable splints and the treatment of their diabetes. In America surgical treatment of the affected joints has been tried, e.g. arthrodesis of the talo-crural joint, but the results were not good as the healing was poor.

All authors are also agreed that suitable splints and footwear should be provided. In this respect one must be careful not to apply pressure since the patient has reduced or absent sensibility.

In cases of need amputation may be involved, but the majority of authors only recommend it as a treatment to save life, and in such a case femoral amputation is the rule.



Fig 8
X ray of knees of pat no 3

SUMMARY

After a short review of the available literature on Arthropathia diabetica 3 cases of this disease are described which were treated at the orthopaedic out patient department Aalborg

The symptoms diagnosis and treatment of the three cases are reported and finally the classification differential diagnosis and various methods of treatment are described

RESUME

Apres avoir sommairement en revue la litterature existant sur l ar thropathie diabetique trois cas de cette maladie traites a la Clinique Orthopedique ambulatoire d Aalborg sont decrits

Il est donne un aperçu des symptomes du diagnostic et du traite ment dans les trois cas Discussions sur la maniere dont la maladie s est manifestee le diagnostic differentiel ainsi que differentes methodes de traitement

Following the conclusion of this work two articles by O Aagenaes and V R Haagensen were published on the same subject U F L 121 569 1959 and U F L 121 572 1959

ZUSAMMENFASSUNG

Nach einer kurzen Durchsicht der vorliegenden Litteratur uber arthropathia diabetica werden 3 Falle dieses Leidens die am ortopedischen Ambulatorium in Aalborg behandelt wurden beschrieben

Man gibt eine Übersicht uber Symptome Diagnose und Behandlung dieser drei Falle und schliesslich erortert man die Entstehungsweise die Differentialdiagnose und verschiedene Behandlungsmethoden

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ROM THE ORTHOPAEDIC CLINIC (HEAD PROF G WIBERG) THE INSTITUTE
OF PATHOLOGY (HEAD PROF C G AHLSTRÖM) IN LUND AND THE X RAY
ABORATORY AVESTA JERNVERKS AB AVESTA (HEAD J BACKLUND fil lic)
SWEDEN

AN X RAY SPECTROGRAPHIC INVESTIGATION OF THE SOFT TISSUE AROUND TITANIUM AND COBALT ALLOY IMPLANTS

By

HANS EMNEUS UNNE STENRAM and JOHANNES BACKLUND

Emneus & Stenram (1960) studied the reaction of soft tissue around metal implants in chickens Histologic sections often showed pigment around the implants This pigment may have come from the implants if so the pigment and the metal implants must contain the same element In some cases the pigment was Turnbull positive which is regarded as evidence of ionized iron In the Turnbull reaction potassium ferricyanide reacts with ferro ions with precipitation of ferroferricyanide so called Turnbull blue It should however be observed that the iron demonstrated need not emanate from the metallic implant but may be derived from the body e g decomposed haemoglobin Turnbull negative pigment was found around titanium and cobalt alloy implants It is difficult to ascertain the metal component if any of such pigment though it is known that cobalt ions react with potassium ferricyanide to give a dark brown precipitate with a violet hue while nickel ions give a yellow brown precipitate (Petersen & Emneus 1960) Chromium molybden and titanium give no precipitate with ferricyanide Further analysis of the Turnbull negative pigment was therefore considered desirable Microradiography with the apparatus available failed Roentgenspectrographic analysis of tissue sections and slices however proved successful The positive and some representative negative results are reported below

The literature on the solubility of vitallium and titanium in living tissue is scanty Using spectrochemical analysis Gillieson (1955) showed the presence of cobalt and chromium in granulation tissue around some vitallium implants in human tissue While the present paper was being

prepared for the press Ferguson Laing & Hodge (1960) published an investigation in which they demonstrated by spectrochemical methods titanium zirconium nickel cobalt chromium molybden and iron in the tissue around metallic implants containing these elements They gave no account of any histologic examinations

MATERIAL AND METHODS

The x ray spectrograph used in the experiments was of commercial type and has been described in detail by Parrish & Engstrom (1956) and Bunn & Parrish (1956)

The instrument consists of an x ray source which irradiates the object with white radiation i e radiation distributed over a wide range of wave lengths a spectrograph which separates the rays retransmitted from the measuring object into components of different wave lengths and a registering apparatus which measures the intensity of one component at a time from the spectrograph

The white rays which impinge upon the object are largely absorbed by the latter and cause a certain amount of fluorescent radiation This contains x rays characteristic of the elements present in the sample and the radiation is divided up into lines by the spectrograph The wave lengths of the lines are characteristic of the element which they belong to and since the wave length can be determined by measurement of the angle in the spectrograph different elements can be identified in this way The intensity of a certain line is dependent on the content of the element in the object but is also influenced by the thickness of the specimen if it is thin and by the presence of heavy elements in the sample Those elements absorb part of the fluorescent radiation

In the experiments the roentgen ray source consisted of a roentgen tube with gold anode fed from a well stabilized high voltage generator with 54 kV and 30 mA direct current The roentgen tube had been checked in previous experiments with analytical objects with high x ray scattering coefficients (water plastics) and the radiation had been examined for characteristic lines Gold and copper lines were found in addition to the continuous white background The copper line was however very weak

The grating of the spectrograph consisted of a ground lithium fluoride crystal with 2 d = 4 028 A series of measurements were made with repeated adjustments of the spectrograph setting to pass the angle of the metal line sought in order to register *background and line* with



Fig 1

A piece of thin connective tissue near a buried titanium rod Turnbull negative pigment in phagocytes A non stained section was analyzed with the x ray spectrograph See table 1 and diagram 1 Magn × 760

good accuracy The intensity was measured with a scintillation detector and electronic scaler This detector absorbs roentgen rays in a sodium iodide crystal which on absorption of the rays gives off a light flash This flash is received by an extremely sensitive photocell a photomultiplier and is counted by the electronic counter as an impulse If the roentgen radiation is intense many flashes per unit of time will be noted Because the roentgen radiation has the character of quantum radiation the measuring process has a certain statistical uncertainty and to decrease this a large number of quanta must be recorded If the radiation is weak the measuring time must be long In these experiments about 12 000 impulses were recorded which corresponds to a standard deviation in the measurement of intensity of about 1 per cent It is this statistical uncertainty and accordingly the intensities and measuring times that decide the maximum sensitivity of the spectrograph in an investigation of this type The experiments were carried out in the following two ways

1 7 μ thick paraffin sections from the material accounted for previously (Linneus & Stenram 1960) were placed in the receptacle of the spectrograph on a thin film of supporting nylon Some of these sections were adjacent to such sections containing a fairly large amount *of pigment concentrated in a small area (Fig 1)*

2 Whole paraffin embedded pieces of tissue were cleaned of paraffin by means of warm distilled water and then placed in the receptacle in the same way

RESULTS

Investigation on titanium

Titanium could be demonstrated in 7 μ thick sections from the 2 experiments where considerable amount of black Turnbull negative pig

ment had been observed histologically (Emneus and Stenram 1960 exp no 16) (see tables 1 and 2) When paraffin was removed and the rest of the tissue examined *en bloc* titanium could not be demonstrated (table 3) in 16 other experiments (Emneus and Stenram 1960 exp no 16 and 17)

TABLE 1

Anode material gold Voltage 54 kV Current 50 mA Scintillation detector 1250 V LiF-crystal Spectograph slit 14 mm Grid no 2 Divisi n factor 4 Spectrograph vacuated Damping of amplifier 34 dB Sectioned tissue from annual 281 See diagr 1

2θ	Imp./30 sec	2θ	Imp 30 sec
85 00	2830	86 00	3080
20	2780	10	2980
40	2820	20	2990
60	2860	50	2830
80	2970		
90	3070		
95	3100		

Standard deviation ± 30 impulses/30 sec

The maximum of the Ti line is at 85 95 in our spectrograph and no disturbing lines appear in the neighbourhood It is therefore concluded that titanium is present in the sample See diagram 1

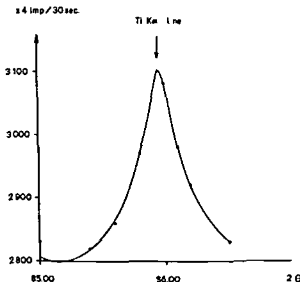


Diagram 1

TABLE 2

Experimental conditions as in Table 1 except that the measurements were made by counting 40 000 impulses each time and by registration of the time necessary for this count Sectioned tissue from animal 27

2Θ	Time in sec for 40 000 imp	Imp/s (aprox)
85 60	155 46	260
70	137 26	290
80	114 60	350
90	97 89	410
95	94 00	430
86 00	92 23	430
10	100 00	400
20	116 71	340

Standard deviation ± 0 5 sec.

In this case al o the presence of titanium could be demonstrated See diagram 2

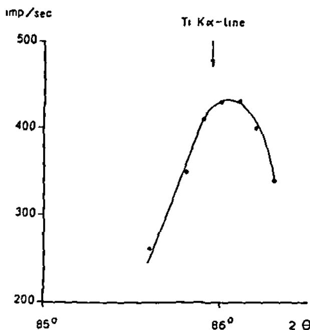


Diagram 2

TABLE 3

Experimental conditions as in Table 1. Tissue not sectioned. Paraffin removed. Impulses/30 sec

Chicken (l = left, r = right)

20	27 l	28 r	29 r	29 l	30 r	30 l	31 r	31 l	32 r	32 l	33 l	34 r	35 l	36 l	37 l	38 l
8,80	2366	4027	2317	3173	3339	2394	3550	2790	3776	3611	3870	3571	3261	3404	2567	3469
8	233	4082	2832	3140	3412	2473	3590	2782	3753	3604	3854	3 78	3249	3383	2462	3493
30	3016	4074	2306	3151	3373	2371	3537	2832	37 0	3645	3865	3510	3240	3476	3551	3503
3	2360	4072	36	3133	3383	333	3506	2817	3805	3556	3313	3554	3252	3455	2556	3454
86,00	2183	4064	2871	3185	3338	2364	3522	2837	3764	3564	3830	3613	3286	3433	2573	3463
0	3028	4034	2305	3133	3318	3605	3552	2837	3631	3520	3305	3510	3207	3423	2576	3457
10	3012	4044	2308	3081	3358	2394	3603	2911	3623	3565	3878	3516	3212	3441	2495	3595

Standard deviation ± 30 imp./sec

In none of these cases was titanium demonstrable in the tissue. See diagram 3

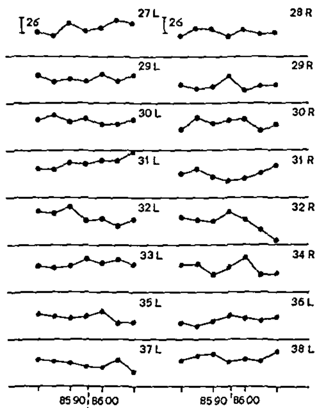


Diagram 3

Investigation on cobalt

Cobalt could not be demonstrated in 7 μ thick sections from 6 experiments (Emneus and Stenram 1960 exp no 13) although pigment had been histologically demonstrated in adjacent sections When paraffin was removed and the rest of the tissue was taken as a whole cobalt was demonstrable in 12 cases out of 18 experiments (Emneus and Stenram 1960 exp no 11–15) (see further Discussion)

TABLE 4

Anode material gold Tube voltage 54 kV Current 30 mA Scintillation detector 1250 V LiF crystal Slit 14 mm Grid no 2 Division factor 4 Spectrograph evacuated Damping 30 dB Tissue not sectioned Paraffin removed Measuring time 60 sec The maximum of the Co Ka line is at 52 65 Standard dev + 30 imp

°θ	15 R	16 L	16 R	17 R	18 R	19 R
52 50	3270	2774	2373	3879	3176	1860
55	3347	2789	2403	4008	3210	1901
60	3424	2808	2422	4108	3256	1883
65	3429	2791	2443	4179	3279	1912
70	3467	2838	2423	4184	3257	1876
75	3432	2788	2445	4123	3246	1862
80	3391	2760	2352	4118	3242	1874
90	3284	2748	2328	3816	31 0	1805

In these 6 cases cobalt was demonstrable See diagram 4

TABLE 5

Anode material W Tube voltage 54 kV Current 13 mA Scintillation detector 1250 V LiF-crystal Slit 14 mm Grid no 2 Division factor 4 Spectrograph evacuated Damping 30 dB Tissue not sectioned Paraffin removed Measuring time 20 sec The maximum of the Co Ka line is at 52 81 Standard dev ± 60 imp

°θ	17 L	20 R	21 L	22 L	23 L	26 L
52 50	1244	1106	1371	1555	1619	1019
55	1256	1151	1441	1589	1743	1000
60	1351	1200	1481	1580	1624	1056
65	1558	1281	1478	1 03	1682	1123
70	1552	1351	1476	1863	1771	1171
75	158	1464	1529	1885	1883	1162
80	1568	1446	1521	19 9	1804	1349
85	16	1488	1614	1965	1896	13 3
90	1468	1408	1567	1949	197	1390
95	1342	1314	1548	1896	1921	1326
53 00	1262	1197	14 0	1714	1843	1245
05	1082	1116	1277	1632	1743	1196
10	1060	104	1337	1 96	1 07	1115
15	985	985	1203	1528	1628	9 0

In these 6 cases cobalt was demonstrable See diagram 5

The spectrograph was changed between the analyses given in table 4 and

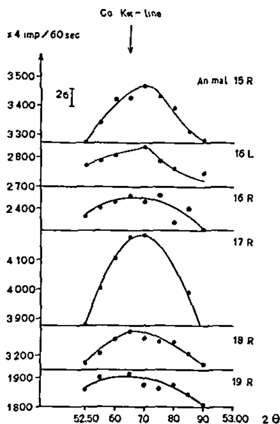


Diagram 4

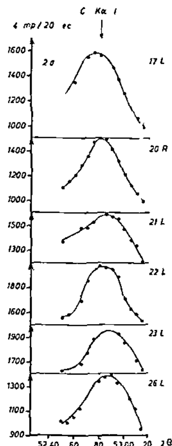


Diagram 5

DISCUSSION

The x ray spectrograph analysis of paraffin sections has thus shown that in 2 cases titanium was present in the tissue around the titanium implants Therefore the black pigment demonstrated previously in adjacent sections by Linneus & Stenram (1960) most likely consisted in part or entirely of titanium compounds Fig 1 Histologic sections showed black pigment also in 8 cases in which the x ray spectrographic analysis of the entire piece of tissue could not reveal the presence of titanium It may be assumed that this pigment was also titanium although it occurred in such small quantities that it could not be demonstrated by the technique used

Cobalt was demonstrated spectrographically in 11 cases out of 12

where implants consisting of soft vitallium and pieces of soft and hard vitallium welded together has been deposited. In 9 of these cases previous histologic examination had shown a relatively large amount of pigment which was dark brown after reaction with potassium ferricyanide, i.e. a colour obtained with cobalt ions. In the light of the x-ray spectrographic analyses it therefore appears to be established that the pigment observed contains cobalt. Cobalt could be demonstrated x-ray spectrographically in one case out of 6 (26 I, Table 5) where only hard vitallium had been deposited. In this case and one other the histologic examination showed dark brown pigment in Turnbull staining. It appears probable that this pigment also contains cobalt.

The investigation thus showed the presence of cobalt and titanium in tissue around some implants of cobalt alloy and titanium respectively. The elements demonstrated must emanate from the metallic implant.

Discussion took place whether the pigment observed might be a fragment torn off the rods (Emneus & Stenram 1960). The surface treatment applied, however, invalidates such an assumption. It is more reasonable to suppose that the pigment had arisen by electrolytic dissolution of the metal and had then been deposited in the tissue (see also Emneus, in press).

SUMMARY

In a previous investigation Emneus & Stenram (1960) demonstrated the appearance of Turnbull negative pigment in the soft tissue around titanium and cobalt alloy implants in chickens. In the present paper an x-ray spectrographic analysis is described which revealed the presence of titanium and cobalt respectively in the tissue. It seems therefore established that the pigment contained these elements. It is assumed that the pigment had arisen by electrolytic dissolution of the metal.

RESUME

Dans une enquete precedente Emneus et Stenram (1960) ont demontre l'apparition de pigment Turnbull negatif dans le tissu mou autour des alliages de titanium et de cobalt implantes chez les poulets. Dans la presente publication il est rendu compte d'une analyse spectrographique aux rayons X qui revele la presence respectivement de titanium et de cobalt dans le tissu. C'est pourquoi il parait etabli que le

pigment contient ces éléments. Il est présumé que le pigment est produit par une dissolution électrolytique du métal.

ZUSAMMENFASSUNG

In einer vorausgegangenen Untersuchung wiesen Emneus und Stenram (1960) das Auftreten von Turnbull negativen Pigment in dem Weichteilgewebe nach, das Einpflanzungen von Titanium und Kobaltlegierungen bei Hühnern umgab. In der vorliegenden Arbeit wird über eine röntgenologisch spectrographische Analyse berichtet, die das Vorhandensein von Titanium und Kobalt im Gewebe aufgezeigt hat. Es scheint daher festgestellt zu sein, dass das Pigment diese Elemente enthielt. Man nimmt an, dass das Pigment durch Elektrolyse des Metalls entstanden ist.

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ON THE UPTAKE OF RADIOACTIVE CALCIUM AND STRONTIUM IN THE SKELETON OF NORMAL AND RACHITIC RATS

By

H. BOHR

Since the investigation of Chievitz and Hevesy (1) in 1937 on the uptake of radioactive phosphate in the skeleton of rats, the radioactive isotopes, especially radioactive calcium and strontium, have been applied to a great extent in the study of bone metabolism.

Different opinions have, however, been held as regards the explanation of the results. Several authors, among those Hevesy (2), Manly (3), Harrison (4) and Newman (5) have taken the view that besides the incorporation through growth, shown markedly in the incisors of the rat, reversible exchange processes seem to account for the main uptake of radioactive calcium, strontium and phosphate in the bone tissue. On the other hand Carlsson and Bauer (6) have stressed the opinion that the greater part of this uptake is determined by accretion and resorbtion processes.

This question has important bearings on the results of investigations with radioactive isotopes in bone transplants and during fracture healing as well as regards the accumulation in pathological processes of the bone tissue, recently demonstrated by Bauer and Wendeberg (7).

An interesting difference between the uptake of radioactive strontium in the bone tissue of normal and rachitic rats killed at different periods after injection of the isotope was found by Jones and Copp (8). Both in normal and rachitic animals uptake was observed, but while in the normal animals the radioactivity remained practically constant during the following days, it was shown that the activity of the bones of the

Presented at the Meeting of the Scandinavian Orthopaedic Society in Oslo, June 1960.

rachitic rats decreased within 8 hours to about one half of the maximum value

These results afford an opportunity to distinguish between different stages in the uptake of radioactive strontium in the bones and in the present investigation the results of the uptake of radioactive calcium and strontium in normal and rachitic rats through measurements on the living animals give further support to such a conclusion

The radioactive calcium isotope Ca^{4} was obtained from Amersham as a carrier free solution in CaCl it has a half life of 4 9 days and the gamma rays emitted have a spectrum with an energy maximum at 1 3 MEV The radiation was measured with a scintillation counter using a bias at 0 4 MEV to eliminate the radiation from Sc^{4} which is the immediate decay product

The beta emitting isotope Ca^{4} with a half life of 160 days used especially in autoradiography was also obtained from Amersham as a carrier free solution of $CaCl_2$

The radioactive strontium isotope Sr^{8} was obtained from the Nuclear and Engineering Corporation Pittsburg as a carrier free solution of $SrCl_2$ in HCl This isotope has a half life of 64 days and emits gamma radiation with an energy maximum at 0 51 MEV The measurements of this isotope were carried out with a scintillation counter using a canal set around the energy maximum

The experiment animals were white rats of the Wistar strain The standard food contained adequate amounts of calcium phosphate and vitamins

Rickets were produced in 4 week old rats which were reared on Steenbock and Black s food No 2965 for 3 weeks without exposure to direct sunlight The contents of Calcium in the food were 1 3 % and that of phosphorus 0 28 % The degree of rickets was controlled by X ray photos of the proximal tibial epiphysis

Through an exposure of the vena femoralis during ether anæsthesia the radioactive isotope was injected intravenously in amounts of about 5–10 μc

Autoradiographic pictures were taken through contacting the tissue sample with Ilford Nuclear Plates G 5 with emulsion thickness of 50 μ Microradiographic pictures were produced with the Philips Contact *Microradiographic Apparatus Type 11990 using Kodac spectroscopic* film No 649-0 Tissue samples were prepared after imbedding in methylmetacrylate by cutting with a saw and grinding to a specimen thickness of about 50 μ

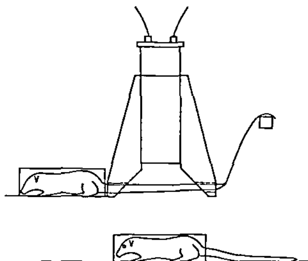


Fig 1

Measurement of the activity top of the tail below of the total body

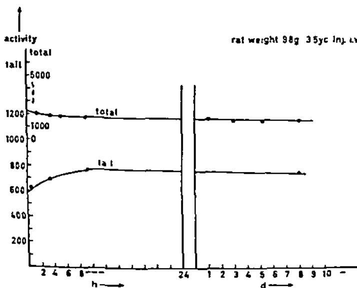


Fig 2

Activity of the tail and the total b dy f n rmal rats f llowing i v inj of C

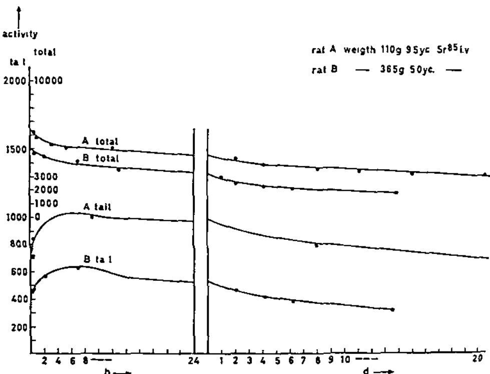


Fig 3

Activity of tail and the total body of normal rats following i v inj of Sr^{85}

Fig 1 shows how the radioactive radiation from the tail was determined when the tail was placed between openings in the lead shield and fastened with adhesive tape The radiation from the total animal was measured when the wire cage of the animal was fixed at a certain distance from the crystal counter These determinations were made almost continuously during the first 2–3 hours after the injection of the isotope and continued with intervals of hours through the first day and then every second or fourth day for about 10–20 days

On Fig 2 the results of the measurements with Ca^{47} on a normal rat weighing 90 g are shown The activity is given in counts pr min after correction for background and decay Every determination was made with not less than 5000 counts the counting error thus being below ± 2 % It can be seen that while the total activity decreases a little during the first hours after the injection of the isotope due to excretion from the rat the activity of the tail rises until a maximum is reached about 8 hours after the injection During the next 12 hours the activity of the tail remains constant and is only slightly reduced

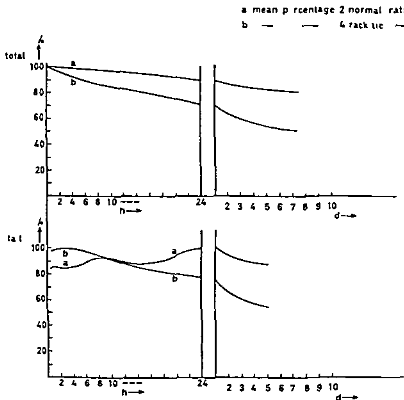


Fig 4
Activity in per cent of the maximal uptake measured in normal and rachitic rats following i v inj of Ca^{45}

during the following days Fig 3 shows that the results with Sr^{85} are practically the same except that the activities of the total animal and the tail decrease at a somewhat faster rate after the lapse of 24 hours than in the case of Ca^{45} In the adult rat B weighing 365 g the results are the same as in the young rat A weighing only 110 g The reduced activities in B are due to a correspondingly smaller amount of radio active isotope injected into this animal

The measurements on the rachitic rats are shown on Figs 4 and 5 where the results are given as percentage deviation from the maximal activities obtained In the rachitic animals the total activity as well as the activity of the tail decrease from about 4 hours after the injection of the isotope In the case of Sr^{85} where the measurements were continued for a longer period the activities of the total body and the tail were

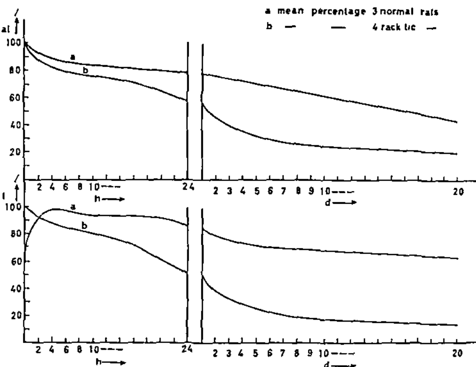


Fig 5

Activity in per cent of the maximal uptake measured in normal and rachitic rats following i v inj of Sr⁸⁹

reduced to 1 5 as compared with the normal animals in the course of 10 days Tables 1 and 2 show that the amount of radioactive calcium and strontium taken up in the rachitic rats during the first hours after the injection of the isotope is just as large as in the normal rats This corresponds well with the results seen on Fig 6 which show that the amount of radioactive calcium in the blood during the first two hours following an intravenous injection of Ca⁴⁵ decreases along almost identical curves in normal and rachitic rats The activity of the blood is measured every 5 min pr 0 025 ml whole blood with a Geiger Muller counter arrangement and the results given as a percentage of the activity in blood calculated at the moment of the injection

Fig 7 shows an autoradiographic picture of a longitudinal section of the tail of a rachitic rat 2 hours after an intravenous injection of Ca⁴⁵ where it is seen that the radioactive calcium is located mainly in the bone The activity of the tail therefore closely corresponds to the amount of radioactive isotope already taken up in the bone tissue 2 hours after the injection

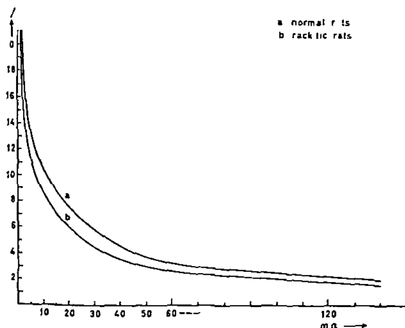


Fig 6
Activity pr ml blood in per cent f the total activity following i v inj f Ca^{45}



F g
Autoradiography of a longitudinal ecti n f the tail of a rachitic rat 2 h ur after i inj f Ca⁴

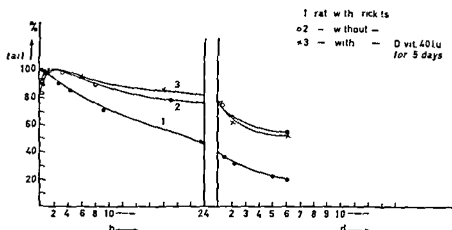


Fig 8

Activity in per cent of the maximal uptake measured in rats on rachitogenic food after i.v. inj. of Sr^{85}

TABLE 1

Relative activities of the tail and the total body of normal and rachitic rats following i.v. inj. of Ca^{45}

		Mean value c/m ½ hour after inj.	Mean value c/m maximal activity
Rachitic rats	tail	901	910
	total		[illegible]393
Normal rats	tail	865	1005
	total		2560

TABLE 2

Relative activities of the tail and the total body of normal and rachitic rats following i.v. inj. of Sr^{85}

		Mean value c/m ½ hour after inj.	Mean value c/m maximal activity
Rachitic rats	tail	1561	1616
	total		7[illegible]00
Normal rats	tail	1203	1493
	total		7400

Fig 8 shows the results of the activity measurements after injection of Sr^{89} into 3 young rats of almost the same weight all of which had been treated with the rachitogenic food of Steenbock and Black and under the same conditions Rat No 1 showed well developed rickets on X ray photos before the injection of radioactive strontium No 2 did not show signs of rickets and in No 3 rickets produced and verified on X ray photos were cured with the addition of 40 I U D vitamin daily for 5 days to the rachitogenic food The different curves demonstrate how the rachitic state of the bones can be shown through the decrease in the activity measured

DISCUSSION AND CONCLUSION

It has been shown by several authors among these Leblond and Greulich (9) Comar Gotz and Boyd (10) Kidman Rayner Tutt and Waughan (11) and Engstrom Bjornerstedt Clemedson and Nelson (12) that the radioactive calcium and strontium injected into the animal in the course of a few minutes rapidly accumulates in the skeleton the main part being taken up already within the lapse of 1 hour

As the bone tissue occupies a greater part of the tail than of the rest of the body it is to be expected that a rise in the activity of the tail should take place during the first hours following the injection of the isotope in agreement with the results shown in the present investigation

The measurements on the rachitic animals have confirmed the observations of Jones and Copp (8) which show that the uptake of radioactive calcium and strontium during the first hour following the injection of the isotope is almost equal in the bones of normal and rachitic animals but that the amount of radioactive isotope in the rachitic bone then decreases to about one half during the next 24 hours while it remains almost constant in the normal bones

Furthermore the present investigations in agreement with the results of Norris and Kisieleski (13) and Bauer Carlsson and Lindquist (14) have shown that strontium at least in tracer doses follows calcium both as regards the uptake in the bone and the intermediate metabolism in bone tissue but that strontium is excreted at a faster rate than calcium from the organism

In Figs 9 and 10 the distribution of the radioactive calcium taken up in the proximal part of the tibia bone 2 hours after an intravenous injection of Ca^{45} into a normal and rachitic rat can be seen through



Fig. 9

Autoradiographs (left) and microradiographs (right) of the proximal end of the tibia from a rachitic rat 2 hours after i.v. inj. of Ca^{45}

comparison of an autoradiographic and a microradiographic picture. It is shown that besides the more diffuse uptake in the bone tissue itself demonstrated in both the normal and the rachitic bone a heavy accumulation takes place on the metaphyseal side of the epiphyseal line in the normal bone which has almost no corresponding phenomenon in the rachitic bone.

From the above mentioned results it can be presumed that the immediate uptake of radioactive calcium and strontium in the bone as seen during the first hours in both normal and rachitic animals is due mainly to a reversible exchange process shown by the decrease in the activity of the rachitic animals during the succeeding hours. And only that part of the activity which is taken up at the epiphyseal line has a possibility of proceeding deeper into the skeleton by accretion processes.

Such a distinction between the primary uptake due to exchange processes and a secondary slower uptake due to irreversible accretion processes is illustrated by the results obtained under different experimental conditions.

Through autoradiographic studies it was thus shown by Engström and coll. (12) that the activity taken up in the skeleton during



Fig 10

Autoradiography (left) and microradiographs (right) of the proximal end of the tibia from a normal rat 2 hours after iv inj of Ca[4]

the first hours after an intraperitoneal injection of radioactive strontium into rats almost entirely disappeared during the following five months Hevesy (15) on the other hand has shown that about one half of the radioactive calcium taken up in the skeleton of mice during the foetal stage through the mother organism is retained throughout the life of the animal

If we want to evaluate the intensity of the accretion processes determining the degree of growth or remodelling of the bones through measurements of the uptake of radioactive calcium or strontium it seems necessary according to the conclusions drawn here to follow such activity over longer periods periods in the case of growing rats likely to be at least 10 days

It is hoped by continued investigation into these questions to obtain further experimental evidence regarding the nature of calcium metabolism under normal and pathological conditions

SUMMARY

The uptake of radiocalcium Ca[4] and radiostrontium given through intravenous injection to normal and rachitic d



Fig 9

Autoradiography (left) and microradiography (right) of the proximal end of the tibia from a rachitic rat 2 hours after i v inj of Ca^{45}

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ZUSAMMENFASSUNG

Die Aufnahme von Radiumcalcium Ca* und Radiostrontium Sr* das mittels intravenöser Injektion an normale und rachitische Ratten verabreicht worden war, wurde mit Hilfe von Messungen der Aktivität des Schwanzes und des gesamten Körpers am lebenden Tiere verfolgt. Während der ersten Stunden nach der Injektion fällt die Aktivität des Gesamtkörpers ein wenig wegen der Ausscheidung von radioaktiven Isotopen durch das Tier, während die Aktivität des Schwanzes auf Grund der Anhäufung von radioaktivem Calcium und Strontium im Knochen ansteigt. Während der ersten Stunde nach der Injektion ist die Aufnahme im Knochen dieselbe bei normalen und rachitischen Ratten. Während jedoch die Aktivität innerhalb der nächsten 24 Stunden bei normalen Tieren konstant verbleibt, zeigt es sich, dass die Aktivität bei rachitischen Ratten innerhalb von 8 Stunden zur Hälfte der grössten Werte herabsinkt.

Diese Ergebnisse, die die vorausgegangenen Untersuchungen von Jones und Copp bestätigen, geben die Möglichkeit zwischen verschiedenen Stadien der Aufnahme von radioaktivem Calcium und Strontium in den Knochen zu unterscheiden. Es scheint daher, dass die unmittelbare primäre Aufnahme hauptsächlich als ein reversibler Austausch zwischen Blut und Knochengewebe angesehen werden muss, und dass der Zuwachs nur infolge einer sekundären, langsameren Aufnahme vor sich geht.

ACKNOWLEDGEMENT

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FROM THE SURGICAL DEPARTMENT (HEAD ARNE ARNESEN)
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HABITUAL SHOULDER LUXATION

Eden Hybinette s Operation

By

KAARE LAVIK

In 1918 at the same time and completely independent of each other Eden in Germany and Hybinette in Sweden described their operative methods for habitual shoulder luxation (h s l)

In Anglo saxon countries the method is little used and there is amazingly little discussion of it in Anglo saxon literature

In Scandinavia on the contrary the Eden Hybinette operative method is much used Especially from Sweden a comprehensive literature exists on E H with h s l Hybinette (1932) Dahlgren (1936) Orell & Petren (1942) Palmer & Widen (1948) Jacobson (1949) Hedman (1952) Thomasen (1944) Hublin (1946)

From Norway publications on E H have been few Bruusgaard (1953) published a study of 15 operated cases in which he employed the original E H method Alvik (1951) preferred to modify this method somewhat

During the 10 year period from 1946–1955 22 operations were performed at the Central Hospital in Trondheim all carefully following the original E H method

Our series comprises only the anterior luxation of the humerus This is a frequent luxation and forms more than half of all luxations

With the arm abducted the axis runs through the shoulder joint aparallel with the sagittal plane of the body but forming an angle of 45 forward of this

There are two pathologico anatomic changes in h s l which it is generally agreed represent important pathogenetic factors in the disease 1) loosening and damage to the joint capsule and the glenoid labrum at the anterior edge of the glenoid cavity 2) impression frac

ture (impression groove) dorsolaterally to the caput humeri These changes were carefully described by Broca & Hartmann in 1890

Blundell Bankart (1938–1948) believes that the sole essential lesion in h s l is the loosening and damage to the capsule and labrum at the anterior edge of the cavitas glenoidale He admits that compression fractures of the caput humeri certainly occur but they are a consequence of and not a cause of the luxations

Palmer (1948) does not completely agree with Bankart and he attributes most importance to the impression fracture dorsolaterally to the caput humeri In Palmer s opinion an intracapsular subluxation occurs in reality with h s l

Tavernier (1930) has also drawn attention to the point that the flattening of the caput humeri may be of congenital origin

Brav (1952) supports in particular this theory about congenital pathogenetic factors In his series of h s l he found a number of cases in which the caput humeri showed the same defect on the healthy non luxated side as on the luxated side A control group of 100 men showed flattening in 28 when the arm was photographed rotated inward ca 50 and abducted ca 45

De Palma (1950) points out that damage and loosening of the capsule and glenoid labrum occur frequently after the age of 30 years and that these findings increase with age so that they are present in almost 100 % after the age of 60 Clinical experience has shown (this is also borne out by our series) that h s l is rare after 30–40 years of age and diminishes considerably with advancing age The change in the glenoid labrum and the capsule on the other hand grows with age

Moberg (1957) is the spokesman for roughly the same point of view as De Palma He believes that the signal apparatus of the shoulder joint is destroyed when ruptures in the muscle ligament apparatus heal with lengthening

Watson Jones (1948–1955) firmly maintains that the arm must be *immobilized for 4 weeks in the inward rotation position after luxations* and that certainly many fewer reluxations would then be seen and so many operative interventions could be avoided

Rowe (1956) found also the highest incidence of recurrence to follow no or only one week s immobilization But the results were no better after 6 than after only 3 weeks immobilization He believes that age plays a great part in reluxations moreover that the severest first time trauma shows the least recurrence

OPERATIVE TECHNIQUE

In the Central Hospital at Trondheim we have employed the original EH method with the same technique as that described by Palmer & Widen (1948)

Placing the patient in the best possible position is not of little import ance at the operation It seems to us that the half sitting position is the best After the shoulder joint is opened it is important to pull the arm strongly backward and rotate it fully outward A good view is then obtained and the joint cavity and joint capsule s anterior rim can be inspected from the inside We chose to take the transplant from far behind on the iliac crest so as to obtain the most suitable form for this The size of the transplant is usually 2 5 × 3 5 cm and should preferably not be less it must be shaped exactly A subperiosteal pocket is made on the forward aspect of the collum scapulae between the anterior mar gin and the labrum The pocket is often found preformed and is then enlarger if necessary The transplant formed as the letter L is placed in the subperiosteal pocket with the flat spongiosa side turned in toward the denuded collum scapulae and with the short leg of the transplant turning inward toward the joint cavity so that it rests on the rima glenoidale The pocket must not be too wide otherwise there may be a risk that the transplant will not hold completely firmly The trans plant must fit the pocket as the finger fits a tight glove We have not usually found retaining sutures to be necessary The joint capsule with the subscapularis tendon is sown firmly together but we have not un dertaken any routine shortening of the latter Since 1949 we have stopped placing the arm on an abduction splint but bandage the arm rotated firmly inward to the body After ca 14 days we unfasten the bandage and as early as this we initiate cautious exercises with the shoulder joint but we take care that no outward rotation occurs in the shoulder joint The patient gets up from the 2nd day post operatively and can as a rule be transferred to the out patient dept after about 3 weeks

PERSONALLY INVESTIGATED MATERIAL

This comprises 22 operations on 21 patients A woman who had bi lateral luxation was operated previously on both sides following Hen derson s suspension method but there was constant recurrence after these operations

All the operations were performed according to the EH original

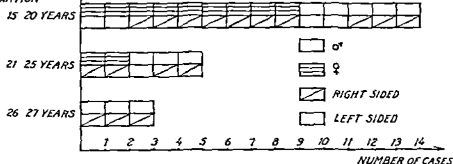


Fig 1

Distribution of age and sex in connection with right and left sided dislocation at primary luxation

method There was no case in which we attempted any modification of the method

The observation period varied from 20 months to 10 years Only in one case was the observation period less than two years

Fig 1 shows the age sex distribution and also the relationship between left and right sided luxations with first time luxation

The average age on 1st time luxation was 20 5 years The youngest patient with first time luxation was 12 years and the two oldest were both 27 years

It is a recognized fact that h s l is found within the younger age groups while the traumatic luxations occur at more advanced ages The average age for traumatic luxations is usually reported to be 50 years while that for h s l is stated in the majority of series to be 22–25 years Thomasen reported an average age for h s l at 22 5 years

The right sided luxations predominated in our series and the figures for right and left side were 17/5 This is a rather higher figure than is usually reported

An interesting point at the follow up examination was the manner in which reduction had taken place after first time luxation In all 8 of the 21 patients managed to put the arm back into place themselves by turning and wriggling with the shoulder blade and arm 6 were given help by chance passers by There were only 8 who had to obtain medical aid for reduction and only 4 of these had to have narcosis In the later reluxations the same patients who had no medical aid for the first time luxation managed to carry out their own reductions the first 4–6 times but afterwards it became more and more difficult to obtain

reduction Finally nearly everyone was forced to have medical aid for reduction in later luxations

3 of our patients had luxation so easily that they had adopted the habit of binding the arm to the body before they went to bed at night

The circumstance that the first luxations were so easy to reduce but that later luxations were more difficult to put back must be attributed to the fact that h s l begins as incomplete luxations and afterwards becomes complete

SIGNIFICANCE OF TRAUMA

On questioning the patients for the first time falls on the arm had been accepted as an adequate trauma 12 of the patients reported that the 1st luxation happened after falling on skis or on smooth ice On closer questioning whether the fall on the arm was very severe the majority stated that it was not On the whole the reply was that they could not understand that an arm could go out of joint for so little

Direct trauma against the shoulder region had occurred in 5 of the patients at the first luxation but 2 of these were slight

In 5 patients after careful and repeated questioning no grounds for adequate trauma could be found To these belonged the patient with bi lateral luxations

It is difficult to establish a criterion whether a trauma is adequate or not If a patient s statements are accepted after only one enquiry I believe that all too many trauma will be regarded as adequate With most injuries there is a tendency to exaggerate the traumas Revision of the traumas involved in 1st time luxation and a more sober evaluation of these give me the impression that the traumas in our series can in many cases hardly have been adequate

IMMOBILIZATION WITH PRIMARY LUXATION

Those patients who had no or merely short immobilization seem to demonstrate the greatest number of reluxations before operation This point is however *not completely clear since the period between the* 1st time luxation and the operation must come into consideration On the other hand it is plain that patients with the severest trauma at the 1st time had the fewest number of reluxations As far as the reluxations are otherwise concerned a majority of these undoubtedly occurred in patients who had easily been subject to 1st time luxation and in whom these were also easily reduced

The period between 1st time luxation and operation was on average fully 10 years varying from 2 to 23 years

PRE-OPERATIVE RADIOLOGICAL FINDINGS

Table 1 shows radiological findings in the 22 luxations before operation The impression fracture of the caput humeri is as a rule missed if the arm is not photographed rotated 50–70 inward and in an abduction position of about 45 Fig 2 a and Fig 3 a show how this is missed with a normal frontal picture Figs 2 b and 3 b show the impression plainly when the arm is photographed in the correct position We can demonstrate a definite impression fracture in more than half the series not including doubtful flattening dorsolaterally on the caput humeri

TABLE 1

Pre-operative x-ray findings	Artrosis	Subluxation position	Impression fract of cap humeri	Fract of tub major	Rounding or defect of glen cavit	Periostitis calcarea	Corp libr
No of shoulder joint	5 (2 bilat)	7 (2 bilat)	12	0	13	3	1

It can be seen from the table that we have not been able to find fractures or sequelae of the above on the humerus otherwise

We found a radiologically demonstrable wearing away or defect in the anterior margin of the glenoid cavity in all 13 patients 3 of these were regarded as definite tears In their case histories these 3 patients had definite adequate trauma against the shoulder region at the primary luxation (kicked by a colt fall downstairs a severe fall on the arm during ski jumping)

Axial pictures revealed 7 subluxation positions bilateral in 2 One of these was the patient operated on for bilateral luxation The other patient complained of pain in both shoulders and arthrotic changes in both shoulder joints were demonstrated in this patient Unfortunately the shoulder joints of both sides were not routine photographed on examination This was only done when the patients complained of trouble from both shoulders



Fig 2a



Fig 2b



Fig 3a



Fig 3b

Figs 2a and 3a

Normal fr ntal picture h w n def t f caput humer

Figs 2b and 3b

With the arm inward r tated 0 0 and al ducted th c i a plain mpr i n gr e d r lat rall n th caput humeri

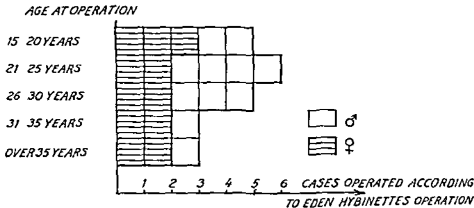


Fig 4
Age and sex distribution at operation

TABLE 2

Operative findings	Injuries or loosening of labrum	Rounded worn glenoid cavity	Defects in anterior margin glenoid cavity	Normal joint capsule	Normal glenoid labrum	Larger or smaller capsule loosening	Corpora libera	Sup r p n rut
No of shoulder joint	17	9	4	9	5	8	2	0

OPERATIVE FINDINGS

Fig 4 shows the age sex distribution at operation of the 21 patients From table 2 which shows the findings from the 22 operations it appears that there is complete agreement between radiological and operative findings as far as the anterior rim of the glenoid cavity is concerned At operation defects in the anterior margin were found in 4 cases and obvious wearing or rounding in 9 cases Thus in more than half the series definite changes were found in the cavity forward and downward It is thought beyond doubt that the changes play a large part as pathogenetic factor in h s l Whether wearing is involved in every case is by no means certain Where the changes forward in the cavity exist in patients with slight primary trauma and a relatively small number of luxations it is reasonable to believe that it is a question of dysplasia and not of any phenomena of wearing away I am more inclined to believe that we are dealing with an important cause of h s l here and not always with a condition resulting from this same disease

The changes found at the glenoid labrum vary from small to complete detachments and injuries In one patient the labrum was completely torn away and lay enclosed in the joint In a few cases it was not possible to find even the remains of the labrum

It is debatable how much importance one should attribute to small detachments of the labrum Gallie & Mesurier (1948) refer to the anatomist Grant (Toronto) who states the labrum is nat constatntly connected firmly to the rim of the cavity but that the attachment may be intermittent The same conditions are also mentioned by De Palma

A free body in the shoulder joint was discovered in two operations The one about the size of a pea was revealed pre operatively by X ray The other on the contrary as large as a shell almond was not discovered at the X ray examination A clear defect was found in the anterior margin in both these patients so an avulsion fracture certainly existed here and in turn gave rise to a free body It is recommended that one should look for free bodies at operation since they are not always diagnosed at routine X ray examination

Capsular injuries were found at operation to be less pronounced In 5 patients it was not possible to discover any deviation from the normal at all at the capsule or labrum but in 3 of these there was a definite rounding of the cavity in front

There were no post operative complications in the series

All patients replied that they were very pleased with the operation and many of them were deeply grateful (One of those operated on had taken part three times in Holmenkollen s ski race after the operation During training on the skiing slopes he had experienced many bad falls following his operation but his shoulder had always held however severe the falls had been)

RECURRENCE

In our series there was one reluxation One may be certainly permitted to regard this as traumatic recurrence owing to the unusually powerful trauma which led to the reluxation 3 5 years after the operation

It has been argued against E H that it would easily produce arthroses in the shoulder joint During the follow up examination we could not demonstrate any more arthroses than were known before the operation

The transplant could be seen to lie forward and downward of the anterior margin in one case only and does not seem to have contact with

the collum scapulae Amongst the others the transplant was found to have healed or to be resorbed

MOBILITY IN THE OPERATED SHOULDER

In the follow up examination mobility in the operated shoulder was compared with that in the healthy shoulder In the great majority of cases the mobility was found to be very good Only 5 patients were ob served to have plainly reduced outward rotation and backward move ment of the arm

None of the patients examined complained of pain in the operated shoulder Only a few reported some tiredness in the evenings This was only when they had worked harder than usual in the day The strength in the arm of the side operated on could be seen in no single case to have diminished when compared with the healthy non operated arm

DISCUSSION

There are indeed few diseases which have been the subject of such a number of proposed and used methods of operation as h s l The ma jority of these have now been dropped A number of operative methods gradually emerged which demonstrably seemed to give the lowest re currence figure In the Anglo saxon countries the methods evolved by Bankart Putti & Platt or Magnusson are mostly used

In Scandinavian and German speaking countries the I H operation has held its own and series from these countries show that the method gives a very low recurrence figure It must be quite definitely stated that the method belongs to the better class

It is in all probability a correct therapeutic principle that all luxa tions must be immobilized for a period after the injury so that possible lesions to the joint apparatus may heal

Personally I believe that the are however a number of luxations of the shoulder which will become recurrent even if the immobilization is complete and correctly executed

The follow up examination of our series seems to show that there may be good grounds for supposing that a luxation of the shoulder will become recurrent 1 if the patient belongs to an age group below 25 years 2 no demonstrably certain primary trauma 3 reduction without difficulty of the primary trauma 4 no injuries to the shoulder joint demonstrable on the X ray 5 if in addition the other shoulder has been luxated

Hereditary dispositions are not regarded on the whole as having any special significance One of our patients had a brother and a cousin *with the same disease Two others stated that a parental brother or* sister suffered from h s l

An important discovery in our series was that in 13 out of 22 luxations there was rounding or wearing of the anterior margin of the glenoid cavity

Loosening of the glenoid labrum in front was the most frequent finding at operation amongst our patients If a slight detachment is found *no particular importance can be attributed to this since Grant and De* Palma have shown that the attachment of the labrum is not always complete With advancing age an increasing number of injuries and detachments of the labrum and the capsule are to be found

Following our investigation our opinion about the F H operation is that the method is very good and that it is fully in a class with the other methods now accepted and employed

We have one recurrence in the series and firmly regard this as purely traumatic since it was a more than usually severe trauma which led to the reluxation 3 5 years after the operation The patient has not had any reluxation during the last 5 years

In our series we have found less restriction of outward rotation and backward movement of the arm than is usually so in those operated according to other methods Too great a limitation of these movements plays no insignificant part in the dynamics of the shoulder joint since outward rotation is from the beginning the weakest of the movements manifested It represents moreover the most important depressor mechanism of the shoulder joint (Alvik 1957)

It was only in 5 patients of our series that we found a slightly reduced outward rotation and backward movement of the arm operated on The changes were so small that none of the patients themselves had noticed them

These *unimportant restrictions we have found can be attributed to* the fact that during the last 6 years we have not immobilized the arm inward rotated to the body more than 14 days after the operation Immediately the period is over we have allowed the patient to have physiotherapy but have of course taken great care that no outward rotation movement occurs during the early days

In our opinion the investigation of our series gives grounds for stating that h s l begins as an incomplete luxation but afterwards develops into a full luxation

Our series even though small also seems to show plainly that h s l affects the younger age groups

If one looks for the average interval between the primary luxation and the operation this will be found to be 10 years If the age group 15–20 years is taken including the primary luxation the interval for 11 of the 14 patients will be seen to be only 3 years The 3 others in this age group were not operated on until 12 20 and 23 years afterwards respectively I believe that the operation should not be postponed too long when diagnosis h s l is a fact

SUMMARY

A follow up survey of 22 h s l operated on according to the original E H method is presented from the Central Hospital of Trondheim

Briefly a review of the problems of the disease is given and the significance of the pathogenetic factors is discussed My personal conclusion is that h s l is caused by the interplay of several factors

The observation period extended from 20 months to 10 years

There were no post operative complications in the series All the patients were very pleased with the operation No one was compelled to change work after the operation

We have not found any grounds for the opinion that the E H operation would easily produce arthrotic changes in the shoulder joint

Our follow up survey shows that the E H operation for h s l is a fully satisfactory procedure

RESUME

L examen complementaire de 22 cas de luxation habituelle de l epaule operes d apres la methode originale Eden Hybinette est presente par l hopital central de Trondhjem

Il est donne un compte rendu sommaire des problemes poses par la maladie et il est discute de la signification des facteurs pathogeniques Ma conclusion personnelle est que la luxation habituelle de l epaule est causee par l interference de plusieurs facteurs

Les observations se sont etendues sur des periodes allant de 20 mois a 10 ans Dans cette serie de cas il n y a pas eu de complications post operatoires Tous les malades ont ete tres satisfaits de l operation Aucun n a ete contraint de changer de travail apres l operation

Un malade a eu une reluxation 3 ans et demi apres l operation

Nous n'avons trouvé aucun fondement à l'opinion que l'opération Eden Hybinette produit facilement des modifications arthrotiques de l'articulation de l'épaule.
Un examen complémentaire montre que l'opération Eden Hybinette dans les cas de luxation habituelle de l'épaule est un procédé entièrement satisfaisant.

ZUSAMMENFASSUNG

Eine Nachuntersuchung von 22 habituellen Schulterluxationen, die gemäss der originalen Eden Hybinette Methode operiert wurden, wird vom Zentralkrankenhaus in Trondheim vorgestellt.
Eine kurze Übersicht der Probleme der Erkrankung wird gegeben und die Bedeutung der pathogenetischen Faktoren wird besprochen. Meine persönliche Schlussfolgerung ist die, dass die h S l durch das Zusammenspiel mehrerer Faktoren hervorgerufen wird.
Der Beobachtungszeitraum reichte von 20 Monaten bis zu 10 Jahren. Keinerlei postoperative Komplikationen entstanden in dieser Gruppe. Alle Patienten waren sehr zufrieden mit der Operation. Keiner war genötigt seine Arbeit zu wechseln.
Ein Patient erlitt eine Reluxation 3 ½ Jahre nach der Operation.
Wir haben keinen Grund für die Meinung gefunden, dass die E H Operation leicht arthrotische Veränderungen im Schultergelenk hervorrufen könnte.
Unsere Nachuntersuchung zeigt, dass die E H Operation für die h S l ein zufriedenstellendes Vorgehen darstellt.

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FROM THE STATE HOSPITAL IN SONDERBORG SURGICAL DEPT
HEAD DR MED PETER WINDFELD

CALVE PERTHES DISEASE RESULTS OF OUT PATIENTS TREATMENT

By

INGE REIMANN

The purpose of this study is to investigate whether the results of out patient weight relieving treatment of patients with Calve Perthes disease are equally as good as the results which are obtained from treatment with lengthy bed rest

Since the disease was described around 1910 as a separate entity it has been the subject of detailed studies First after the introduction of the X ray into diagnostics the disease became distinct from other hip diseases especially tuberculous coxitis

In 1909 Waldenström (2a) described some cases which both clinically and radiologically correspond with the picture of disease now designated as Calve Perthes disease

Similarly in 1909 the American Legg described some cases of hip disease in children which were clearly distinct from the coxitis In 1910 both Calve (5) and Perthes (18) described some cases and in 1913 Perthes (18) recorded it as a well defined disease with the name Osteochondritis deformans juvenilis coxae

Since then countless cases have been reported

The series

51 patients with Calve Perthes disease form the material for this study all treated at the State Hospital of Sonderborg in the surgical department during the years 1948–1955 and followed up 1958–1959 at the earliest 3½ years and at the latest 10 years after commencement of treatment

The patients are followed up regularly both with clinical and roentgenological examination

Etiology

In the etiology special interest was paid to trauma endocrine diseases

and hereditary dispositions Information about trauma of an acceptable character in the anamnesis can only be provided in 4 cases Nothing definite was found from an endocrinous point of view however one of the patients was previously treated for myxoedemia In 4 cases at the first examination the nutritional state was found to be considerably above average Only in 2 cases could any information be obtained about hip disease in the family one of the patients has a brother who has had epiphysiolysis coxae and one has an aunt who has had congenital hip luxation no case of Calvé Perthes disease has occurred in the family

Sex distribution follows the norm for there is a clear preponderance of boys thus 23 of the patients are boys which equals 74 % and 8 of the patients are girls (26 %)

The cases are divided into 13 right sided 16 left sided and 2 bilateral cases

The patients age at the onset of disease varies from 3 14 years with an average age of 7 years most are about 5 years

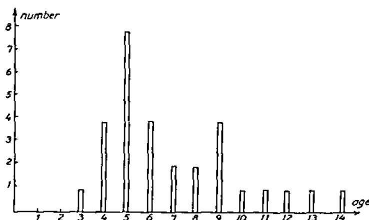


DIAGRAM 1

The clinical picture is typical in all cases beginning with limping and slight limitation of movement In 29 of the cases the first symptom was slight limping in 5 cases there was pain in the hip from the beginning and in 2 cases pain in the knee

In the majority of the cases the first clinical examination took place within the first half year after the onset of symptoms but otherwise the period beween the onset of symptoms and the first examination varied from 1 week to 2 years

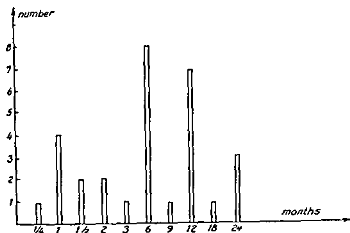


DIAGRAM 2

At the first clinical examination the following were found

limping in 29 cases
pain on walking in 7 cases
Trendelenburg test positive in 5 cases
shortening in 5 cases varying from ½ to 1½ cm
atrophy in 23 cases very often femoral atrophy crus atrophy only in 3 cases (found amongst patients with femoral atrophy)

Mobility

completely free mobility in the hip in 3 cases
limited abduction and rotation in 21 cases
limited rotation (very often inward rotation) in 4 cases
contracture in 3 cases

With regard to the treatment of patients in this series the following groups can be established

1) Exclusively out patient treatment with weight relief using the Thomas splint 5 patients

2) Stay in hospital until the diagnosis is made afterwards out patient treatment with the Thomas splint and regular control both clinically and by X ray For these patients the hospital stay lasted on average 2 weeks (One patient however had first a lengthy hospital stay owing to treatment for congenital hip luxation on the same side) 17 patients

3) Those treated first with extension owing to contracture at the first examination afterwards given out patient treatment with weight

relief using the Thomas splint Stay in hospital was on average 4 weeks 3 patients

4) Bilateral cases one patient transferred to "Refsnaes and treated there with 1½ years bed rest one patient treated with ½ year s bed rest at home afterwards out patient weight relief using the Thomas splint as the one side was only slightly affected 2 patients

5) First treated elsewhere (Refsnaes) with bed rest for 7 months afterwards transferred here and treated with out patient weight relief using the Thomas splint 1 patient

6) Symptomatic treatment since on admission there were old changes not susceptible of treatment 3 patients The patients in groups 4 5 and 6 (in all 6 patients) are not included with those given exclusively out patient treatment with the Thomas splint

The treatment with the Thomas splint lasts on average 2½–3 years The patients come for frequent examinations about every 3 months both clinically and by X ray and the treatment by Thomas splint continues until there is radiological healing The check up is made at the surgical ambulatorium repair and possible renewal of the splint is undertaken at the Invalid Institute workshop we are not given the impression that the patients have omitted to use the splint

On re examination the following was found

All patients state they are free of pain however 2–3 patients admit a feeling of tiredness after a fairly long period of weigth bearing and walking

5 patients state there is a slight limp sometimes

The Trendelenburg test was negative in all cases

Shortening was found in 13 patients (on average ½–1 cm one with 3 cm)

In scarcely half the patients was there atrophy femoral atrophy in 12 (on average 1–2 cm one with 5 cm however) crus atrophy in 8 of the 12 (on average ½–1 cm with one 3 cm)

The findings for mobility were

complete freedom of mobility in 10 patients

limited abduction and rotation in 16

limited rotation in 2 no case of contracture

At the re examination all patients were found to carry on their work or school activities without hindrance ⅓ of the patients take part in gymnastics and sport 17 were children still going to school otherwise the remainder were employed in various trades 3 worked on the land there were 2 butcher apprentices 1 office clerk 3 machine apprentices

1 cook and 1 electrical apprentice Those patients employed in hard manual labour were advised to change their work

None of the patients had completed their military service since those who had been called up were all rejected Radiological changes were noticed and it was decided that the heavy weight bearing which they would be exposed to would increase the risk of secondary arthrosis

The radiological results showed changes from spherical shaped to severely deformed capita none of the results were 100 % normal by comparison with the healthy side but none revealed signs of secondary arthrosis

In order to evaluate the radiological changes more closely methods of measurement were employed as described by the Americans Herndon and Heymann in 1950

4 quotients are calculated

1) To express the flattening and increase in breadth of the head a caput quotient (caput epiphysis quotient) is recorded in which the relationship between the height and width of the caput epiphysis is expressed in % and calculated by comparison with the healthy side The quotient is not pathological until it is below 85 %

2) To express the changes which may arise in the collum in both increase in breadth and shortening a head neck quotient is recorded and calculated as the relationship between the distance from the border of the collum facing the diaphysis to the top of the caput and the breadth of the collum and is expressed in % and calculated in relation to the healthy side

3) The increase in breadth and flattening which may occur in the acetabulum is expressed as an acetabular quotient This is calculated as the relationship between the depth of the acetabulum and the breadth of the acetabulum expressed in % and calculated in relation to the healthy side

4) Finally a caput acetabular quotient is recorded as an expression of the subluxation of caput for the increase in breadth of the caput has the effect that the caput is not laterally covered by the acetabulum this quotient is calculated as the relationship between the distance between the caput medially and the acetabulum laterally and the distance between the caput medially and the caput laterally in % (between vertical lines) and calculated in relation to the healthy side

In the present series when calculating the quotients of those patients exclusively treated as out patient with Thomas splint it was found

The caput epiphysis quotient was 65 % on average those patients

B
A
B
A
HEAD-NECK QUOTIENT

$$\frac{A / B \times 100}{A_I / B_I \times 100} \cdot 100$$

CAPUT-EPIPHYSIS QUOTIENT

$$\frac{A / B \times 100}{A_I / B_I \times 100} \times 100$$

B
A
A
B
ACETABULAR QUOTIENT

$$\frac{A / B \times 100}{A_I / B_I \times 100} \times 100$$

CAPUT-ACETABULAR QUOTIENT

$$\frac{A / B \times 100}{A_I / B_I \times 100} \times 100$$

Fig 1



Fig 2

No 23 Boy aged 5 symptoms for 3 months Increased joint width 10/3/53

who at the first examination showed pronounced advanced radiological changes were omitted In all 4 patients were involved and these patients all had symptoms 1–2 years before treatment began

The head neck quotient was on average 84 %
The acetabular quotient was on average 88 %
The caput acetabular quotient was on average 85 %



Fig 3
No 23 8/3/ 6



Fig 4
N 23 8 3 56 Lauenstein projection pronounced change

The comparison of the results stated by the various authors is made difficult by the use of different principles of evaluation

The problem in the treatment is still how long and how effectively the patients ought to be treated with bed rest and weight relief There seems to be agreement that the younger the patient and the earlier he comes for treatment the better will be the results

In 1924 Flemming Moller (1) published 72 cases in his thesis The treatment was symptomatic with 1–2 months bed rest and in cases of contracture treatment by traction Flemming Moller recommends that



Fig 5

No 23 7/8/58 Caput epiphysis quotient 88 % Head neck quotient 98 % acetabular quotient 98 % caput acetabular quotient 95 %



Fig 6

No 15 Boy aged 7 symptoms for ½ year Increased width of joint and flattening 2/3/53

thyroidin treatment always be tried The results are evaluated according to the clinical and roentgenological changes

As the first to introduce methods of measurements in the evaluation of the radiological end results Ivre Brook brought in the term caput index in order to obtain a mathematical expression for the flattening and increase in breadth of the caput Caput index refers to the relationship between the height and breadth of the caput epiphysis expressed



Fig. 7
No. 15 14/8/53



Fig. 8
No. 15 18/4/58 Caput epiphysis quotient 68% head neck quotient 83 acetabular quotient [illegible] caput acetabular quotient [illegible]

in [illegible]%. Eyre-Brook records normal values and reports those for children under 7 years to be 45%–[illegible]%, for children over 7 years [illegible]. In 1936 he published a series of 41 patients from The Royal National Orthopedic Hospital. The patients were divided into groups according to both age (over or under 7 years) and treatment: either traction in bed 1–2 years, or out-patient weight relief. After calculation of the caput index the group under 7 years obtained the best results after



Fig 9
No 1 Girl aged 5 symptoms for 1½ years 23/10/48

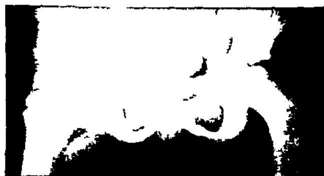


Fig 10
No 1 27/5/49

traction in bed while the group over 7 years obtained approximately equally good results from the two groups

Sundt (24) concluded in 1949 from a series of 153 patients that the results of the untreated and the treated cases were identical But none of the patients in Sundt's series was treated consistently either with lengthy bed rest or with lengthy out patient weight relief (maximum ½ year bed rest) 65 of the 153 patients were not treated and 88 were treated the treatment was symptomatic very often only a few months bed rest The results are reported as good fairly good and poor according to the caput's shape

In 1951 Mindell and Sherman (13) published 73 cases from The Department of Surgery University of Chicago The patients were treated



Fig 11

No 1 18/1/38 Caput epiphysis quotient 43% head neck quotient 64% acetabular quotient 78% caput acetabular quotient 83%



Fig 12

No 8 Boy aged 7 Symptoms for ½ year 20/3/41

partly with lengthy bed rest partly with lengthy out-patient weight relief The results of the two principles of treatment were stated to be equally good and were recorded in 3 groups according to the following criteria 1) good i e symptom free few degrees of limitation in rotation and abduction slight muscle atrophy X-rays show no deformity and good congruence of the articular surfaces 2) fairly good i e pain with lengthy weight bearing 1 2 cm shortening slight atrophy The X-ray showed moderate flattening and increase in width of the caput slight irregularity of the caput possibly slight irregularity of the aceta-



Fig 13
No 8 13/5/50



Fig 14
No 8 29 7/58 Caput epiphysis quotient 78 % head neck quotient 83 % acetabular quotient 100 % caput acetabular quotient 69 %

bulum and a rather short and broad collum 3) Poor i e pain and limp up to 4 cm shortening considerable atrophy limited rotation and abduction The X ray shows severe deformation of caput collum and acetabulum

McCarrol and Pedersen (19) (from the Shriners Hospital for Crippled Children & The Department of Surgery Washington University School of Medicine St Louis) compare also 2 groups of similar patients each group numbering 12 patients the one group treated with traction in bed (1–2 years) the other group treated with out patient weight relief (2-3

years) The best results come from patients treated with traction in bed the results are given by the caput index for patients treated with traction in bed index 37 6 % for patients treated with out patient weight relief 25 3 %

1952 Herndorn and Heymann (12) published a series of 41 patients from The University Hospital Cleveland who were treated first with traction in bed for an average period of 6 months until regeneration commenced then with out patient weight relief using the Thomas splint until there was radiological healing The following results are stated

The caput quotient averages 66 9 % (47 7–100)
The head neck quotient averages 86 7 % (72–100)
The acetabular quotient averages 88 6 % (70–100)
The caput acetabular quotient averages 89 3 % (73–100)

In his thesis of 1953 dealing with 204 patients Helbo (11) recommends treatment with lengthy bed rest (ca 1 year) then out patient treatment with crutches and Snyder s sling 66 patients were followed up with this treatment and the results of the clinical and radiological changes are stated An average caput quotient of 67 % is reported The results of the untreated and the symptomatic treated cases are reported to be equally with an average caput quotient of 40 % Helbo states that 95 % of the untreated cases will be symptom free at the primary healing but the caput will often be somewhat deformed so there is great risk of secondary arthrosis

In 1958 Evans and Lloyd Roberts (9) compared 2 groups of identical patients each group of 24 patients the one group was treated with traction in bed the other with out patient weight relief with crutches and Snyder s sling (From The Royal National Orthopedic Hospital London) They concluded that the results of the 2 principles of treatment were equally good and the results were reported as good fairly good and poor since both the clinical and radiological changes were taken into consideration

In 1959 Wansbrough Carrie Walker & Ruckerbauer (26) published from The Research Institute of the Hospital for Sick Children Toronto a large series of 129 patients Out patient treatment with Taylor s splint is recommended The results of both the clinical findings and the radiological findings are given quotients are calculated as described by Herndon and Heymann

Remvig (20) published 1959 some previous results following lengthy weight relief treatment during bed rest. The series consisted of 20 patients and the results were stated according to the clinical and radiological changes. 80 % good and 20 % poor results were found.

Author	Year	No. pat.	Treatment	Results
Fl. Møller	1924	72	symptomatic 1–2 months bed rest, thyroidin	clinical and radiological good and poor
Eyre Brook	1936	41	1) traction in bed 2) out patient weight relief	caput index under 7 years 1) = better, over 7 years 1) & 2) almost equally good
Sundt	1949	153	symptomatic interrupted bed rest max ½ year	good, fairly and poor clinical and radiol. Untreated = treated
Mindell & Sherman	1951	73	1) lengthy bed rest 2) out patient weight relief	good, fairly and poor equally good results from and 1) and 2)
McCarroll & Pedersen	1951	24	1) traction in bed 2) out patient weight relief	caput index 1) 37.6 % 2) 25.3 %
Herndon & Heymann	1952	41	traction in bed average 6.3 mths, then out pat. relief with Thomas splint	caput quotient 66.9 % head neck quot. 85.7 % acetabular quot. 88.6 % caput acetabular quotient 89.3 %
Helbo	1953	66	bed rest about 1 yr, then out patient weight relief with Snyder's sling	clinical and radiological caput quotient 67
Evans & Roberts	1958	48	1) traction in bed 2) out pat. weight relief with Snyder's sling	good, fairly and poor 1) and 2) equally good result
Wansbrough, Carrie, Walker & Ruckerbauer	1959	129	out patient weight relief with Taylor's splint	excellent, good, fairly and poor clinical and radiological quotients
Remvig	1959	20	lengthy bed rest	good 80 %, poor 20 %

CASE HISTORIES

No 1 Out patient girl aged 5 reporting symptoms for 1½ years before treatment began. 1 X ray shows pronounced changes with obvious flattening and fragmentation of the caput epiphysis She was treated with the Thomas splint for 2 years The re examination showed 1 cm shortening and limited abduction and rotation Caput quotient 43% head neck quotient 64% acetabular quotient [illegible]8% and caput acetabular quotient 83%

No 2 Out patient boy aged 4 reporting symptoms for [illegible] year before treatment 1 X ray shows increase in joint width and initial flattening Treated with Thomas splint for 3 years At the re examination complete freedom of movement was found Caput quotient 80% head neck quotient 100% acetabular quotient 100% and caput acetabular quotient 95%

No 3 Out patient boy aged 7 reporting symptoms for 1½ months before treatment 1 X ray shows increase in joint width and initial flattening Treated with Thomas splint for 2 years At the re-examination he was symptom free with free mobility in the hip Caput quotient 88% head neck quotient 95% acetabular quotient 100% and caput acetabular quotient 100%

No 4 Out patient boy aged 6 reporting symptoms for [illegible] year before treatment 1 X ray shows increase in joint width and initial flattening Treated with Thomas splint for 3 years At the re examination 1 cm shortening was found with free mobility of the hip Caput quotient [illegible]8% head neck quotient 94% acetabular quotient 88% caput acetabular quotient 9[illegible]%

No 5 Out patient boy aged 9 reporting symptoms for several years 1 X ray shows flattening and some irregularity Treated with Thomas splint for [illegible] years At the re examination 1 cm shortening was found limited abduction and rotation Caput quotient 56% head neck quotient [illegible]8 acetabular quotient 8[illegible]% and caput acetabular quotient 80%

No 6 J no [illegible]96/49 girl aged 4 reporting symptoms for 1 month before treatment 1 X ray shows increase in joint width and slight flattening Treatment with Thomas splint was given for 1½ years At the re-examination the patient was symptom free there was free movement of the hip Caput quotient [illegible]0 head neck quotient 84 acetabular quotient 100% and caput acetabular quotient 100

No 7 J no 1225/49 boy aged [illegible] He reported symptoms for 1 month (after trauma) before treatment 1 X ray shows increase in joint width and slight flattening. Treated with Thomas splint for 4 years At the re examination slight femur and crus atrophy together with limited abduction and rotation Caput quotient [illegible]0 head neck quotient [illegible]0% acetabular quotient 100 and caput acetabular quotient 82

No 8 J no 839/49 boy aged 7 1 X ray shows increase in joint width and slight flattening Treated with Thomas splint for 3 years At the re examination there was limited rotation otherwise natural conditions Caput quotient 78 head neck quotient 89 acetabular quotient 100 and caput acetabular quotient [illegible]

No 9 J no 148[illegible]/[illegible]0 boy aged 8 reporting symptoms for [illegible] year before treatment 1 X ray shows increase in joint width and slight flattening Treated with Thomas splint for 2 years On re examination here 1 cm shortening was found with 1 cm femur atrophy limited abduction and rotation Caput quotient [illegible]0 head neck quotient 80 acetabular quotient 87 and caput acetabular quotient 100

No 10 J no 687/51 girl aged 6 Reporting symptoms for ¾ year before treatment 1 X ray shows increased width in joint and initial flattening On re examination limited abduction and rotation were found Caput quotient 57 % head neck quotient 54 % acetabular quotient 84 % and caput acetabular quotient 88 %

No 11 J no 1208/51 12 year old boy reporting symptoms for 1 year before treatment 1 X ray shows increase in joint width and slight flattening Treated with Thomas splint for 3 ½ years On re examination 1 cm shortening was found with limited abduction and rotation Caput quotient 60 % head neck quotient 83 % acetabular quotient 95 % and caput acetabular quotient 95 %

No 12 J no 1852 52 boy aged 9 reporting symptoms for 1 year before treatment began 1 X ray shows pronounced changes with flattening breaking up and fragmentation Treated with Thomas splint for 3¼ years On re examination 1 cm shortening was found 2 cm femur and 1 cm crus atrophy together with limited abduction and rotation Caput quotient 45 % head neck quotient 81 % acetabular quotient 80 % and caput acetabular quotient 69 %

No 13 J no 507–53 boy aged 6 Reporting symptoms for ¼ year 1 X ray h ws initial flattening and sclerosis Treated with Thomas splint for 4½ years On re examination 1 cm femur atrophy and limited abduction and rotation Caput quotient 57 % head neck quotient 88 % acetabular quotient 91 caput acetabular quotient 98 %

No 14 J no 1159/53 girl aged 3 Previously treated for congenital luxation of the hip 1 X ray shows increase in joint width and initial flattening Treated with Thomas splint for 2 year On re examination free mobility of the hip was found Caput quotient 50 % head neck quotient 95 % acetabular quotient 100 % and caput acetabular quotient 6? %

No 15 J no 288 53 boy aged 6 Reported symptoms for ½ year (after trauma) before treatment 1 X ray shows initial flattening and increase in joint width Treated with Thomas splint for 4 years On re examination 1½ cm femur atrophy and limited rotation Caput quotient 68 % head neck quotient 83 % acetabular quotient 75 % and caput acetabular quotient 93 %

No 16 J no 1096/55 boy aged 5 Reported symptoms for ½ year before treatment (After trauma) 1 X ray shows increase in joint width and initial flattening Treated with Thomas splint for 3 year on re examination 1 ½ cm shortening was found 5 cm femur and 1 cm crus atrophy free mobility Caput quotient 68 head neck quotient 100 % acetabular quotient 95 % and caput acetabular quotient 9? %

No 17 J no 1955/55 boy aged 5 Reported symptoms for 1 week before treatment 1 X ray shows increase in joint width and initial flattening Treated with Thomas splint for 2 ½ year On re examination free mobility was found 1 cm shortening and ? cm femur together with 1 cm crus atrophy Caput quotient 74 % head neck quotient 100 % acetabular quotient 95 and caput acetabular quotient 84 %

No 18 J no 1874/49 boy aged 8 Reported symptoms for ½ year before treatment 1 X ray shows joint width and flattening treated first with Thomas splint for 1 ½ years then admitted for traction treatment for 6 weeks owing to contracture then again treated with Thomas splint for 1 ½ years On re examination 1 cm shortening was found with 1 ½ cm femur and ½ cm crus atrophy as well as limited abduction and rotation Caput quotient 47 % head neck quotient 6? % acetabular quotient 80 % and caput acetabular quotient 80 %

No 19 J no 20/9 55 boy aged 11 Reported symptoms for several years before treatment began 1 X ray shows increase in joint width and flattening treated with Thomas splint for ? years On re-examination limited abduction and rotation were found. Caput quotient 58 % head neck quotient 77 % acetabular quotient 93 and caput acetabular quotient 98 %

No 0 J no 813/51 girl aged 5 reporting symptoms for 2 months before treatment 1 X ray shows increase in joint width and initial flattening Treated with Thomas splint for 3 years On re examination slight limping 1½ cm shortening 1 cm crus atrophy (previously poliomyelitis with pareses of right leg) limited abduction and rotation Caput quotient 0 % head neck quotient 78 acetabular quotient 80 % and caput acetabular quotient 91 %

No 21 J no 1004/48 girl aged 9 Reported symptoms for 1 year before treatment 1 X ray shows pronounced changes with flattening and fragmentation Treated with Thomas splint for ½ year first then she was admitted for traction treatment for 3 weeks owing to contracture then again treated with Thomas splint for 2½ year On re examination 1 ½ cm shortening was found 2 cm femur and 1 cm crus atrophy as well as limited abduction and rotation Caput quotient 45 % head neck quotient 75 % acetabular quotient 100 % and caput acetabular quotient 83 %

No 22 J no 125/51 boy aged 14 reported symptoms for fully 2 years 1 X ray shows considerable changes with flattening and deformation Treated first with traction for 4 weeks owing to contracture then given out patient treatment for ½ year again admitted for traction treatment for 4 weeks then treated as an out patient with the Thomas splint for 1 ½ years On re examination 3 cm femur atrophy was found limited abduction and an absence of rotation The patient declares he is free of pain Caput quotient ca 21 % head neck quotient 78 % acetabular quotient 80 % caput acetabular quotient 75

No 23 J no 455/55 boy aged 5 reported symptoms for 3 months before treatment 1 X ray shows increase in joint width and initial flattening Treated first with traction for 3 weeks owing to contracture then given out patient weight relief with Thomas splint for 3 years On re examination free mobility was found with ? cm femur and 1 cm crus atrophy Caput quotient 88 % head neck quotient 98 % acetabular quotient 98 % and caput acetabular quotient 95 %

No 24 J no 1038/49 boy aged 10 reported symptoms for 1 year (after trauma) before treatment 1 X ray shows increase width in joint and flattening Treated with Thomas splint first for ½ year then admitted owing to contracture and treated with traction for 6 weeks then treated again with Thomas splint for 2 ½ years On re examination ½ cm shortening was found 2 cm femur atrophy and free mobility Caput quotient 71 % head neck quotient 85 acetabular quotient 100 % and caput acetabular quotient 80 %

No 25 J no 1465/47 14 year old boy Reported symptom for 1 year before treatment 1 X ray shows increased joint width First treated with Thomas splint for year then treated by traction for 6 weeks then again by Thomas splint Operated on later subtrochanteric osteotomy owing to ankylosis in the adduction contracture Re examined ½ year afterwards when there was no trouble 1 cm shortening and limited mobility The patient did not wish to attend for follow up examination.

No 26 J no 223/51 boy aged 5 Reported symptoms for 1 month before symptoms began 1 X ray shows flattening. He was treated elsewhere with 7 8 month

bed rest transferred here and treated with Thomas splint for 2½ years could not be traced after moving away

No 27 J no 2274/51 boy aged 4 Reported symptoms for 2 months before treatment Bilateral case treated with only ½ year's bed rest then given out patient weight relief with Thomas splint (the one side was only slightly attacked) At the re examination limited abduction and rotation were found on both sides otherwise normal conditions X ray shows moderate flattening on the left side almost natural conditions on the right side

No 28 J no 1097/5? boy aged 5 Reported symptoms for 1 year before treatment began Bilateral case treated with bed rest for 1½ years (Refsnaes) At the re examination limited abduction and rotation were found on both sides X ray shows the capita slightly flattened

No 29 J no 856/48 girl aged 4 Reported symptoms for 1½ months before treatment First treated in Germany with plaster 1 X ray shows flattening and sclerosis Treated symptomatically here Not examined (living in Rostock) but information by post stated no subjective trouble

No 30 J no 1879/48 girl aged 5 Reported symptoms for 1 month Treated first elsewhere with bed rest and traction for several months treated here symptomatically At the re examination 1 cm shortening limited abduction and rotation Caput quotient 35% head neck quotient 58% acetabular quotient 74% and caput acetabular quotient 69%

No 31 J no 1300/48 boy aged 13 symptoms for 1 year 1 X ray shows flattening and rarefaction in the collum Treated symptomatic and as an out patient At the re examination limited abduction and rotation were found Caput quotient 62% head neck quotient 9?% acetabular quotient 82% and caput acetabular quotient ?0%

CONCLUSION

In the present series the results obtained from the out patient weight relief treatment of Calve Perthes disease with the Thomas splint (results reported both clinically and by measurements of the radiological end changes) were found to compare so equally with the results reported from patients treated with bed rest of long duration that the out patient treatment can on this basis be recommended corresponding with what other published series have demonstrated Out patient treatment is to be preferred on economic social and psychological grounds since the patients who are very often boys aged 5–6 during the out patient treatment may remain at home may take part in school activities may be taken around amongst those of equal age this is advantageous to their development often retarded by lengthy bed rest and a stay in hospital even if much is done to occupy and instruct them

More uniform methods are to be desired in evaluating the results of the treatment since one would like to have more knowledge of the difference apparent between the results of those patients given insuf

ficient weight relief over a short period and the patients treated with lengthy weight relief either with bed rest or as out patients in addition which form of lengthy weight relief is to be preferred

SUMMARY

A re examination of 31 patients treated for Calve Perthes disease was made 25 of these were treated as out patients with lengthy weight relieving treatment (Thomas splint) The patients were regularly examined both clinically as well as with X rays treatment was extended until healing was noted on the X rays

Different methods of treatment and their results are discussed including methods of measurements which evaluate the radiological end changes and comparisons are drawn between the values recorded in the literature and the values found in the present series The out patient treatment is recommended as the results found seem to be equivalent to the results obtained following treatment with lengthy bed rest

RESUME

31 malades traites pour la maladie de Calve Perthe ont ete reexamines 25 d entre eux ont ete soumis a un traitement par soulagement du poids en longueur (attelle de Thomas) sans etre alites Les malades ont ete regulierement examines aussi bien cliniquement qu aux rayons X Le traitement a ete poursuivi jusqu a ce que la guerison ait pu etre enregistree aux Rayons X

Differentes methodes de traitement et leurs resultats sont discutes y compris les methodes de mensuration pour evaluer les modifications radiologiques finales et des comparaisons sont faites entre les valeurs enregistrees dans la litterature et les valeurs trouvees dans la presente serie Il est recommande de ne pas traiter les malades par l alitement etant donne que les resultats obtenus paraissent etre equivalents a ceux obtenus a la suite d un traitement avec tres long alitement

ZUSAMMENFASSUNG

Eine Nachuntersuchung von 31 Patienten die wegen Calve Perthes scher Erkrankung behandelt worden waren wurde vorgenommen 25 von diesen wurden als ambulatorische Patienten mittels langdauernder Entlastung (Thomas Schiene) behandelt Die Patienten wurden regel

bed rest transferred here and treated with Thomas splint for 2½ years could not be traced after moving away

No 27 J no 2294/51 boy aged 4 Reported symptoms for 2 months before treatment Bilateral case treated with only ½ year's bed rest then given out patient weight relief with Thomas splint (the one side was only slightly attacked) At the re examination limited abduction and rotation were found on both sides otherwise normal conditions X ray shows moderate flattening on the left side almost natural conditions on the right side

No 28 J no 1097/52 boy aged 5 Reported symptoms for 1 year before treatment began Bilateral case treated with bed rest for 1½ years (Refsnaes) At the re examination limited abduction and rotation were found on both sides X ray shows the capita slightly flattened

No 29 J no 856/48 girl aged 4 Reported symptoms for 1½ months before treatment First treated in Germany with plaster 1 X ray shows flattening and sclerosis Treated symptomatically here Not examined (living in Rostock) but information by post stated no subjective trouble

No 30 J no 1829/48 girl aged 5 Reported symptoms for 1 month Treated first elsewhere with bed rest and traction for several months treated here symptomatically At the re examination 1 cm shortening limited abduction and rotation Caput quotient 35 % head neck quotient 58 % acetabular quotient 74 % and caput acetabular quotient 69 %

No 31 J no 1900/48 boy aged 13 symptoms for 1 year 1 X ray shows flattening and rarefaction in the collum Treated symptomatic and as an out patient At the re-examination limited abduction and rotation were found Caput quotient 69 head neck quotient 97 % acetabular quotient 82 % and caput acetabular quotient 90

CONCLUSION

In the present series the results obtained from the out patient weight relief treatment of Calve Perthes disease with the Thomas splint (results reported both clinically and by measurements of the radiological end changes) were found to compare so equally with the results reported from patients treated with bed rest of long duration that the out patient treatment can on this basis be recommended corresponding with what other published series have demonstrated Out patient treatment is to be preferred on economic social and psychological grounds since the patients who are very often boys aged 5–6 during the out patient treatment may remain at home may take part in school activities may be taken around amongst those of equal age this is advantageous to their development often retarded by lengthy bed rest and a stay in hospital even if much is done to occupy and instruct them

More uniform methods are to be desired in evaluating the results of the treatment since one would like to have more knowledge of the difference apparent between the results of those patients given insuf

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FROM THE ORTHOPAEDIC HOSPITAL DEPARTMENT I (HEAD PROFESSOR A BERTELSEN M D) COPENHAGEN DENMARK

ON THE TREATMENT OF ADVANCED SLIPPING OF THE UPPER FEMORAL EPIPHYSIS

By

ISTVAN ADORJAN

Slipping of the upper femoral epiphysis is called severe or advanced in cases where the displacement of the femoral head exceeds one third of the diameter of the femoral neck or is greater than 1.5 cm The slipping is called mild when the displacement is less than this[1]

Though an exact distinction can hardly be made its practical purpose is to divide the patients into mild and severe cases

Firstly the prognosis is different as in cases with mild slipping necrosis of the femoral head practically never occurs when the patient is not treated and it is seldom found after treatment while on the other hand this complication is unfortunately quite common in cases with advanced slipping both without and after different kinds of treatment

Oram in a material of 179 cases of slipped capital epiphysis collected from the Orthopaedic Hospital in Arhus from 1936 to 1949 showed that among 77 hips with severe slipping an avascular necrosis of the femoral head was found in 23 cases i e more than 7 times more frequently observed than among 102 cases with only mild slipping where it occurred in only 3 cases

The second aspect which *makes distinction between* severe and mild cases desirable lies in the different measures of treatment to be taken

There is no difference of opinion as to the treatment of cases with mild slipping as far as correction of the displacement is not considered

[1] The distance from the center of the femoral head to the axis of the femur was measured in the Lauenstein projection as recommended b
of measuring the displacement along the margin of the ne
remodelling takes place making it difficult to find the landr

to be necessary and the treatment should be directed only towards prevention of further slipping This can be done successfully by internal fixation in situ or by epiphyseodesis e g by drilling through the epiphyseal plate The latter method has given satisfactory results in department I of the Orthopaedic Hospital Copenhagen as reported by *F R Mathiesen* in 1958

If slipping however is already advanced when the treatment begins the function is generally so greatly impaired by the adduction and external rotation contracture by shortening of the limb by diminution of the range of motion of the joint and by the limp that correction of the deformity is desirable

Several methods are available to obtain correction closed reduction open reduction osteotomy or wedge osteotomy on the site of the deformity or distally to this i e on the trochanteric or subtrochanteric region of the femur It is very tempting to try closed reduction particularly in cases with fracture like symptoms in an early stage Reduction to the anatomical position can be obtained under these circumstances but the risk of an avascular necrosis of the femoral head is considerable *Waldenstrom* puts it to ca 20 per cent *Watson Jones* to at least 25 per cent *Jerre* found it in 10 cases out of 24 successful reductions i e 41 7 per cent

Open reduction and osteotomy on the site of the deformity was abandoned by most authors in favour of a wedge osteotomy to avoid injury by tension of the retinacular vessels during reposition This is especially important in slowly developed slippings where secondary changes of bone apposition on the anterior and superior surfaces of the neck woulud also make an anatomical restoration without removing a wedge impossible

The justifiability of this method of treatment was however eventually doubted as avascular necrosis of the femoral head was often observed after this treatment

In the Symposium of the British Orthopaedic Association on Slipped Upper Femoral Epiphysis in 1959 there was not a single defence of the wedge osteotomy and compensatory trochanteric or subtrochanteric osteotomy was recommended in cases with advanced slipping where nail fixation alone was impossible and the function had become impaired *G Wiberg* in 1959 evaluated the results of 84 wedge osteotomies performed in 4 Swedish hospitals and found 23 incidences of necrosis of the femoral head i e 27 per cent This leads him to advocate cautiousness in the use of this method

In order to add to the clarification of this question the wedge osteotomies performed in Department I of the Orthopaedic Hospital Copenhagen over a six year period from 1952 to 1958 were reviewed

21 patients with advanced slipping were admitted one of them having severe displacement in both hips One case with fracture like symptoms was treated with closed reduction and internal nail fixation In one case no wedge was excised by the operation as the reduction was performed after linear osteotomy 20 hips of 19 patients were operated on with wedge osteotomy One case was excluded in this series as the patient was 26 years old when operated for slipping on the still open epiphyseal plate She had marked endocrinological disturbances such as diabetes insipidus amenorrhea and was therefore not considered to be a typical case The papers of another patient had been borrowed by the Invalidity Board and could not be obtained

While the principles followed in the 18 wedge osteotomies in this series were uniform as excision of the wedge followed cautious reduction and internal fixation, there were many differences in the details of the technique as the operations were performed by 7 different surgeons One operated on 7 one 5 the others 1 or 2 hips This fact seems to be an advantage when evaluating the method for the results are not absolutely dependent on the skill of one specially trained surgeon The Smith Petersen approach was used in 9 cases Gibson s in 6 Watson Jones in 2 and Wagner Donovan s in 1 case A Smith Petersen nail was only used in 1 case a lag screw in 4 Nystrom s thin nails in 4 operations while in the others two or three Kirschner wires were inserted to fix the reduced head on the neck One of the surgeons preferred to take the wedge more distally the others however on the site of the deformity just beyond the epiphyseal plate In one case there was no immobilization in cast in two cases the cast was removed after three weeks in 6 cases after 6 weeks in 8 after 8 weeks and in 1 after 12 weeks In the postoperative period a Thomas splint was worn in 4 cases After the immobilization period all cases were given physical reeducation with active and passive exercises No si nt difference in the result was observed which might arise f other individual detail of technique as described above

The youngest patient was 11 years and 6 months and ' years old at the operation There were 13 boys and 5 gi was operated in 11 cases the left in 7 cases 2 both hips One of them was operated on both hi tomy the other with drilling and then wedge oste

the hips showed advanced slipping The rate of slipping varied from 18 to 40 mm on an average 27 4 mm

In this series only two of the cases had acute fracture like symptoms as in this country the acute traumatic cases are generally admitted in the regional surgical departments All the other patients had a longer history with intermittent pain mostly localized to the knee and—or—a limp lasting from 1 month till about a year The observation time varied from 14 months till 7 years and 2 months on an average 4 years and 1 month In all cases the epiphysis was open at the time of opera tion At the evaluation of the results the radiological aspect was pre ferably taken into consideration as the future fate of the joint is more dependent on this than on the actual clinical picture

In some cases there was found a difference between the clinical and the radiological finding but always such that the clinical picture was better han the radiological one

	very good	good	fair	bad
radiologically	6	5	4	3
clinically	8	6	2	2

In one third of the operated hips (6) the radiological aspect at the reexamination was very good The position of the head was almost anatomical and the only visible consequence of the preceding opera tion was a slight shortening of the femoral neck in some of the cases All these and two other patients had nearly normal mobility of the joint no limp no complaints at all and a shortening of less than 1 cm On the other hand total failure occurred in 3 cases the first one pre senting an unusual complication among wedge osteotomies not uni maginable however after an osteotomy in the trochanteric or sub trochanteric region namely a pseudarthrosis

The second and third failure was due to necrosis of the joint cartilage resulting in a considerable reduction of the mobility of the joint This complication may however develop without any form of treatment as *Jerre* has pointed out He found this condition in two cases which had not received any form of treatment and in two other cases after as atraumatic interventions as immobilization in plaster of Paris for some weeks without previous reduction in one case and after traction for 7 to 8 weeks in the other case One of our failures also clearly showed radiological signs of narrowing of the joint space as well as a marked diffuse atrophy of the bones in the hip region even preopera

tively Besides these characteristic radiological signs of necrosis of the joint cartilage this patient had a nearly complete clinical ankylosis before the operation The other patient with cartilage necrosis was reoperated one and a half years after the wedge osteotomy At the reoperation the capsule was found adherent to the rather irregularly shaped and usurated cartilage Capsulectomy followed by several mobilizations under general anaesthesia and intraarticular compound F administrations could not prevent recurrence of stiffness These complications could not with certainty be avoided by trochanteric or subtrochanteric osteotomy as these seem more to be a consequence of the pathological condition in itself than of the treatment In cases where signs of these conditions are already found preoperatively wedge osteotomy should be avoided

The remaining 9 cases of the series were classed in two groups one containing 5 hips in which the shortening of the femoral neck in the radiological picture was a little more marked resulting in a higher position of the top of the greater trochanter or there were slight signs of of initial osteoarthritis namely a light sclerosis in the acetabular roof As already mentioned two of these cases had as perfect function as those classed in the best group the others also having good mobility with an ability to flex the hip at least to a right angle These patients however would occasionally notice a slight tenderness in the hip region after overcharging In this group the gait was normal

In the other group there were 4 hips Here more marked signs of osteoarthritis were observed e g moderate reduction of the [illegible] of the joint space sclerosis in the acetabular roof subchondral and moderate irregularities in the shape of the femoral he[illegible] of them who had had a partial avascular necrosis recov[illegible] without significant deformation of the articular surface was not bad in this group either i e flexion to 90 in o[illegible] in two and to 120 in the fourth case

When evaluating the justifiability of a method of risks of course must firstly be taken into considerati[illegible] pleteness of the successful results should not be negl[illegible] be gained with a successful wedge osteotomy Whe[illegible] risks—avascular necrosis of the femoral head and cartilage—one must remember that these complicat[illegible] in the spontaneous course of the disease In 136 [illegible] cases *Oram* found avascular necrosis and as cartilage necrosis was observed in 4 out of 9 cases

without any or after very harmless and ineffective conservative measures The results must finally be compared with those of trochanteric or subtrochanteric osteotomies which have recently been recommended again by many surgeons as the method of choice in the treatment of advanced slipping of the upper femoral epiphysis *G Wiberg* calls for reviews of large series of patients treated with subtrochanteric osteotomies This happened a short time ago when *Imhauser* reported the results of 50 osteotomies performed in the trochanteric region He distinguishes between four types of displacement of the femoral epiphysis dependent on the collodiaphyseal angle When this is 155–160 the epiphysis deviates in a lateral behind below direction when 140 in a behind below when 120–125 in a medial behind below and when 90 in a forward below direction as shown in special so-called orthograde radiological pictures 42 of the osteotomies were performed in cases with purely behind below slippings 30 of them were classed as very good 7 as good 2 as fair and 3 as bad while the 8 osteotomies in lateral behind below slippings could not yet be finally evaluated Among the bad results one showed a necrosis of the femoral head the second a cartilage necrosis while the third case had not been precisely defined it was operated too early The osteotomy should be postponed to a time when the epiphysis has already obtained at least a partial bony fixation on the neck In cases where signs of capital or cartilage necrosis had developed during the preoperative treatment operation was not performed and the question is whether these cases would be those which after a wedge osteotomy on the site of the deformity would have had the worst results The trochanteric ab or adduction osteotomy combined with flexion and inward rotation of the distal fragment is apt as shown by *Imhauser* to improve the correlation of the joint surfaces to each other with restoration of the functional capacity of the hip joint but nothing is known about the late consequences of the markedly changed position of the femoral neck and trochanters which must be followed by change in the course of the short hip muscles and the ileopsoas

Jerre cites *Lutken* who had collected the results of 12 subtrochanteric or transtrochanteric osteotomies bad in 4 cases and poor in 2 cases *Oram* in the Scandinavian Anglo-American German and French literature from 1889 till 1950 found 60 cases with the following results 28 good 14 fair 14 bad and 4 unknown

The wedge osteotomy does not represents an ideal treatment at all because of the rather high percentage of failures All efforts should be

directed towards the prevention of at least the severe slipping by early diagnosis and treatment in the phase of moderate displacement as emphasized by *Newman* In cases of advanced slipping however, the wedge ostetomy according to our experience has sufficient advantages not to be abandoned After closure of the epiphysis when there is no more danger of spontaneous necrosis of the femoral head it would however not be wise to expose the patient to the risk of a necrosis by a wedge osteotomy on the site of the deformity

SUMMARY

Wedge osteotomies in the treatment of advanced slipping of the upper femoral epiphysis were reviewed in order to elucidate more clearly whether this method of treatment is further justifiable in spite of the increasing number of the reported bad results owing to necrosis of the epiphysis or the joint cartilage

Out of 18 wedge osteotomies over a 6 year period one third had very good results one sixth bad and one half good (5) or fair (4) results No total necrosis was observed in this series Three partial necroses recovered and were classed as fair Among the bad results one developed a pseudarthrosis and two were due to cartilage necrosis

It is emphasized that avascular necrosis of the femoral head and the joint cartilage may occur in the spontaneous course of the condition too

As no other treatment offers as perfect results as the good group of wedge osteotomies this method of treatment according to our experience must not be abandoned

RESUME

Les osteotomies en coin dans le traitement du glissement avance de l epiphyse femorale superieure ont ete etudiees en vue d etablir plus clairement si cette methode de traitement continue a etre justifiée malgre le nombre des mauvais resultats rapportés en raison de la necrose de l epiphyse ou du cartilage de l articulation

Parmi 18 osteotomies en coin pratiquees sur une pe[illegible] six
on a constate de tres bons resultats chez un tie[illegible]
mauvais resultats chez un sixieme des resultats bo[illegible]
ment bons (4) dans la moitie des cas Il n a pa[illegible]
totale dans cette serie d observations Trois
gueries et ont ete classees parmi les resultats

Parmi les cas ou les resultats ont eté mauvais il s'est développé une pseudarthrose chez l un et une necrose du cartilage chez deux

Il est souligne que la necrose avasculaire de la tête fémorale et du cartilage de l articulation peut egalement apparaître spontanément

Etant donne qu aucun autre traitement ne donne des résultats aussi parfaits que ceux du groupe des bons resultats selon nous cette méthode de traitement ne doit pas etre abandonnée

ZUSAMMENFASSUNG

Keilosteotomien als Behandlung von *vorgeschrittenen Epiphysengleitungen der proximalen Femurepiphyse wurden nachuntersucht um* deutlicher klarzulegen ob diese *Behandlungsmethode trotz der zunehmenden Zahl von wegen Kopf- oder Gelenksknorpelnekrose, berichteten schlechten* Ergebnisse *immer noch berechtigt ist*

Von 18 Keilosteotomien zeigte ein *Drittel ein sehr gutes Ergebnis* uber einem Zeitraum von 6 Jahren ein *Sechstel ein schlechtes, und* die Halfte ein gutes (5) *oder* ziehmlich gutes (4) *Ergebnis Keine voll*ständige Nekrose wurde in dieser Serie *beobachtet Drei partielle* Nekrosen erholten sich und wurden als *ziehmlich gut bezeichnet* Von den schlechten Ergebnissen kam es in einem *zur Pseudarthrosen*bildung und zwei wurden durch Knorpelnekrose *hervorgerufen*

Man hebt hervor das ischamische Nekrosen des *Femurkopfes und* des Gelenksknorpels auch spontan im Verlaufe der *Erkrankung auf*treten konnen

Da keine andere Behandlung so vollkommene *Ergebnisse ergibt als* die gute Gruppe von Keilosteotomien sollte diese *Behandlungsmethode* gemass unserer Erfahrung nicht verlassen werden

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FROM THE SANATORIUM FOR TUBERCULOSIS IN THE BONES AND JOINTS KAKASSZÉK AND THE CENTRAL RESEARCH INSTITUTE OF THE BLOOD TRANSFUSION SERVICE BUDAPEST HUNGARY

ARTHROPLASTY USING OF BIOPLAST IN TUBERCULOUS COXITIS

By

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In the therapy of articular tuberculosis the aim has for a long time been to preserve the mobility of joints but up to recent times there has not been much chance of success The advent of *antituberculotics* raised great hopes also in this sphere and in fact the number of spontaneously healed mobile joints has increased particularly in cases where treatment was started early enough Unfortunately arthroplasty with the application of metal or synthetic interpositums to promote mobility did not yield good results and in the literature opinion became general that the use of vitallium or acrylate caps in tuberculosis of the joints was contraindicated

The absorbable cap produced from fibrin powder by high pressure represents a significant advance (Fig 1) This synthetic material of protein named bioplast shows affinity with the tissues contains no toxic or carcinogenic substances and possesses the required consistency and elasticity more important than any other quality however is its susceptibility to being broken down by proteolytic enzymes and absorbed By the aid of chemical pre treatment absorption time can be regulated to take from three or four weeks to seven to eight months as required

The first models were given a trial in the hip joints of dogs by Zinner Gerendas and Biro (11) and then on the basis of the results in clinical practice A fibrin cap—fashioned to fit the joint in shape and size—placed on the femoral head prevents merging ossification of contiguous articular endings After operation the cap promotes mobility of the limb and under its protection cartilage develops on the articular surfaces owing to the influence of function Finally six to eight months



Fig 1
Bioplast cap

following implantation—when regeneration has run its course—the cap is absorbed and disappears without leaving behind any trace This circumstance ensures in the most favourable manner free motion of the joint (2 3)

Therapy of tuberculous coxitis aimed at restoring motion calls for consideration of three aspects

Whether maintenance of or insistence on motion involves no danger of relapse

Differentiation of cases where mobility is desirable from those where stable stiff joints offer an advantage

The most suitable procedure for obtaining good motion in articular tuberculosis

1) Prior to the introduction of antituberculotics the view was as good as unanimous that a tuberculous process can be healed only by complete ossification therefore the objective was to stiffen the joint at any price However observations recorded during the ten years that have elapsed since initiation of the use of antituberculotics have drawn attention to many angles that might lead to more complete healing of tuberculosis in the joints (1 4 6 10)

For several years full recovery and satisfactory motion have been noted in the treatment of early superficial or synovial processes In most instances well functioning joints have been obtained after elimination of foci and necrectomy Resection in coxotuberculosis has also been followed by uneventful recovery as well as restoration of good motion within a few months and the favourable results persist after the passage of several years Hence in these cases the maintenance of motion has exerted no harmful effects on the course of tuberculosis Still more encouraging is the fact that the dreaded dangers of former

times miliary and meningeal dissemination have not been encountered among our more than 3000 cases of osteotuberculosis treated in the last ten years It is therefore plausible that we are in favour of restoring motion (7)

2) In our experience endeavours to retain motion are worthwhile in every case where the slightness of articular destruction permits hope of success If after a time it becomes obvious that the joint shows functional insufficiency associated with pain and inadequate capacity only then is the stabilizing operation performed To further our efforts we omit—if possible—the application of plaster and employ intensive water cure and physiotherapy when tuberculosis has assumed quiescence

3) The literature agrees on the point that arthroplasty with vitallium and other prostheses does not produce favourable results and is thus contraindicated in general (5 8) However as evidenced by our experiences fibrin caps too ensure the maintenance of motion while owing to absorption their use is free from the serious disadvantages of prostheses moreover they contribute to the development of smooth articular surfaces and are well tolerated by tuberculous tissue

In 1955 these considerations induced us to begin the use of fibrin caps in hip resections So far we have performed twenty operations The present paper gives a report on ten cases where the follow up period since surgery has been two to three years The results of later operations are not evaluated here but we may remark that they are equally encouraging

METHOD

Our operated cases include five male and five female patients (Tal

Pretreatment usually takes one to three months Rest is e by extension in the presence of severe pain by plaster As med tous therapy Streptomycin (SM) + isonicotinic acid hydrazid or INH + para aminosalicylic acid (PAS) are administere bination The object of pretreatment is to obtain regression tion increases and the joint is threatened by the danger of sive destruction the patient is operated on without delay

Indication — Stiffness and limited mobility of the con constitute absolute indications for surgery Apart fro toms slight destruction in the case of children you persons with a sedentary occupation is also regarded for surgery Patients having to perform difficult move

TABLE 1

No.	Name	Age	Sex	Onset of disease, years	Diagnosis	Histology
1	B. J.	8 year	boy	$\frac{1}{2}$	Tuberculous coxitis, right side	Tuberculosis
2	K. M.	14 years	girl	4	Tuberculous coxitis, right side	Regressive tuberculosis
3	B. T.	13 years	girl	2	Tuberculous coxitis, left side	Caseous tuberculosis
4	Sz. Z.	23 years	girl	6	Tuberculous coxitis? left side	Chronic inflammation
5	B. J.	12 year	boy	1	Tuberculous coxitis, right side	Regressive tuberculosis
6	B. I.	16 years	boy	1	Tuberculous coxitis, right side	Regressive tuberculosis
7	M. M.	8 year	boy	[illegible]	Tuberculous coxitis, right side; tuberculous spondylitis in dorsal vertebrae 8, 9, 10, 11	Regressive tuberculosis
8	Sz. Cs.	15 year	boy	$\frac{1}{2}$	Tuberculous coxitis, right side; Dislocation of coxa, left side	Caseous tuberculosis
9	T. M.	3 years	girl	$\frac{1}{2}$	Tuberculous coxitis, left side	Tuberculosis
10	H. I.	32 years	woman	$\frac{1}{4}$	Tuberculous coxitis, right side	Granulation tuberculosis?

right position fare better with stable stiff joints. However final decision usually depends on surgical findings: in most cases of hip resection we therefore make preparations also for the use of arthroplasty with a fibrin cap.

Surgical Technique.—Exposure is performed by Smith Peterson's incision (9). *The diseased articular parts are removed by resection and* the surfaces are shaped as in preparation for plastic surgery with vitallium. Any defects of the head or the articular acetabulum are filled with "blood cake" chips taken from the hip bone, SM and penicillin powder. The "blood cake" is made by mixing of blood from the cavity and fibrin thrombin powder. After filling of the defects the cap is pulled on the femoral head. If the chief site of infection is in the articular acetabulum a cap of adequate size is placed in the latter and the head set. In the case of active suppurative processes through drainage is applied and after operation plaster is put on the pelvis for a period of two or three weeks. Irrigation with a solution of SM + INH + *penicillin is effected daily until the development of secretion* has ceased completely, which generally ensues in four to ten days. In regressive cicatrizing processes drainage and plaster are omitted, preference is given to extension traction.

After Treatment. Mobilization of the affected limb requires the most careful individual consideration. Initiation of active and passive movement in bed should rely strictly on clinical, laboratory and X-ray findings. As a rule perfect rest is observed for two to four weeks, then physiotherapy is gradually introduced followed by baths and subaqueous exercise. Usually the patient begins to move about with crutches after two or three months while treatment is continued. The *time for starting unaided movement is determined by the patient's condition* and capacity. Antituberculotics are administered during the whole time of therapy (Table II).

CASES

Ten patients have *been followed up for two or three years* (Table III)[1]. The most encouraging results are demonstrated by the fact that the tuberculous process has healed in all of these ten cases, articular capacity is good, the patients use no aid and walk without pain.

Perfect motion has been obtained in three cases, in one case motion

1 Our cases are under control at present since five years. They are showing further improvement. Our new cases are also successful.

TABLE II

No	Pre-treatment			Operation	After Treatment			
	Time	Stabilisation	Drug employed	Date	Extension on Plaster Bed first months	Initiation of physiotherapy in the months	Standing up in the month	Start of walking in months
1	2	plaster	SM INH	Sept 15 1955	1	1	4	6
2	3	extension	SM INH	Oct 2 1955	1	1	2	3
3	2	extension	SM INH	Oct 20 195	1+1	1	9	11
4	2	plaster	SM INH	Oct 26 1955	1	1	6	8
	1	extension	SM INH PAS	Nov 29 1955	1	1	2	4
6	4	extension	SM INH PAS	Jan 10 1956	1	1	2	3
7	1	plaster	SM INH PAS	Jan 12 1956	1	1	1 ½	4
				July 8 1955 Spondylodesis				
8	2	extension	SM INH PAS	Febr 2 1956	1	1	2	24
9	[illegible]	extension	SM INH PAS	Jan 24 1957	[illegible]	5	6	8
10	2	extension	SM INH	April 2 1957	1	1	2	12

TABLE III

No	Before operation	Motion per cent — After operation: flexion	abduction	adduction	Tuberculosis	Pain upon motion	Load bearing capacity	Time of results months	Follow up period year
1	painful contractura	100	100	100	healed	absent	excellent	6	3½
2	absent	30	20	20	healed	absent	excellent	8	3½
3	painful contractura	90	100	100	healed	slight	good	24	3½
4	absent	bone anchylosis			healed	absent	excellent	8	3½
5	absent	50	20	20	healed	absent	excellent	6	3½
6	absent	80	100	100	healed	absent	excellent	12	3¼
7	absent	40	20	20	healed	absent	good	6	3
8	painful contractura	50	50	50	healed	absent	improving	24	3
	absent	50	10	10	healed	absent	excellent	9	2
	ainful contractura	90	100	100	healed	slight	good	18	2




Fig 2 A *Fig 2 B*

Fig 2 A Radiograph prior to operation Presence of sequestrum in the acetabulum is clearly visible at Y cartilage

Fig 2 B Radiograph after one year following operation The actetabular focus has been completely filled

is good in five satisfactory but not quite complete In one operated patient subluxation was followed by anchylosis Since entire freedom from symptoms persists no fresh operation has been undertaken

For the purpose of illustration three case records are presented in detail

Case No 1 J B., a boy aged 8 years was admitted on Jul 13 1955 with com plaints of six m nths standing in the right hip joint At admission a 150 flexion adduction contracture was f und causing intense pain n every attempt at motion particularly up n abduction adduction and extension The periarthric region was swollen A plaster b ndage was put on the pelvis and a c urse of SM+INH treat ment started The general conditi n improved but a radi l g revealed in reased d tructi n f the acetabulum (Fig 2 A) urger was undertaken on Sept 15 1955 The articular soft p rts were f und to be case us the acetabulum cartilage wa c mpletely destr yed and at the Y ch ndru th re wa an appr ximately nut sized l ne lt tructi n spreading towards th p lvi The f m ral he d appeared t be intact Aft r complete l an ng f the a t bulum the urface wa ef rmed and the acet bular d fect seal d w th a f brin p I t p r t e treatm nt c n i t d f extension and the admin trati n f SM+INH Aft r a m nth the pr ce wa c m pen ated thu a ti e and p e ph si the ap a l gun in l d nd completed l ulaque us xerci e In th f urth m nth th p t nt ul l u c rut he wa free fr m c mpl int an l n th xth m nth w l l t w lk naid d Since h di charge n May 21 19 6 we have e n the pati nt r th m nth la t time on January 18 19 9 A l own by r l l gy the l ne d f t ha been full r pla d in ne ve r M ti n i c mpl tel free an l p inle pa its g d F g 2 (and D)

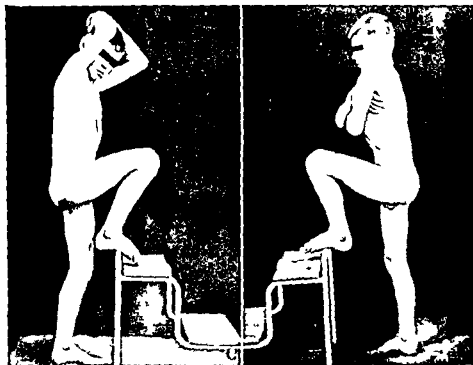


Fig 2 C Fig 2 D

Fig 2 *C* Perfect motion of the right hip restored in six months
Fig 2 *D* Statically complete function in the right hip

Case No 2 L B a boy aged 16 years was admitted on October 20 1955 with complaints of 12 months standing He had been given INH+PAS his abscess had been tapped several time and he wore a walking machine At admission the joint was fixed a few degrees motion occasioned severe pain and at the side over an area as large as a palm some fluctuation could be suspected Operation was performed on January 10 1956 Preoperative radiology (Fig 3 A) had disclosed an uneven constricted articular orifice and small foci in the acetabulum as well as in the femoral head with sclerotic environment Surgical findings accordingly showed cicatrized granulation and destroyed cartilage An abscess filled with turbid exudate was found between the buttock Histological investigation confirmed the diagnosis of regressive tuberculosis After operation (arthroplasty with fibr... bandage was left on for two weeks extension and SM+INH w... currently In a month the patient s condition had greatly impr... and subaqueous exercises were carried on and some wal... When discharged on April 16 1956 he could walk with... pain flexion was 60 Since then he has been seen every ... on January 18 1959 A year after being discharged the ... whatever flexion amounted to 30 and radiology showed ... in the joint (Fig 3 B) Support was found to be excellent



Fig 3 A



Fig 3 B

Fig 3 A Preoperative radiograph of right hip The joint is uneven constricted destroyed but signs of sclerosing are visible

Fig 3 B Radiograph six months after operation Articular cartilage surface is developing



Fig 3 C



Fig 3 D

Fig 3-C Painless 60 flexion [illegible]

Fig 3 D Statically excellent function in right hip



Fig. 4 A

Preoperative radiograph of pelvis. In the left hip congenital dislocation of the coxa. Complete absence of support. On the right the iliac focus visible over the outer part of the acetabulum has invaded the latter



Fig. 4 B

Reverse radiograph of right hip. The process threatened to destroy the whole coxa, therefore surgery was undertaken immediately

Case No. 3. Gy. Sz., a boy aged 15 years, was admitted on November 16, 1955 with complaints of six months' standing in the right hip. Congenital dislocation of the left coxa was associated with a 12 cm. shortening and the absence of static function (Fig. 4 A). An abscess had developed on the right side. As pre-treatment we employed SM+INH, INH+PAS, extension, then incision and topical treatment of fistula and abscess with SM+INH solution. Since in reverse radiology the coxa showed increased destruction of the acetabulum and the femoral head was suspected of sequestration, we decided on surgery. The operation was performed February 1956. Right side hip joint resection was performed along with iliac necrectomy, arthroplasty with bioplast, and excision of the fistula. As verified by surgical findings, a green nut-sized acetabular focus had spread and invaded laterally the joint. The synovia and the [illegible] displayed tuberculous destruction. The greater part of the femoral head was affected together with the cartilage; there was atrophy but no sign of sequestration. The diseased parts were removed and the articular surfaces *reformed. When the resulting defects had been filled with a mixture* [illegible] SM + penicillin and clotted blood, the fibrin cap was fitted on the femoral head. Then by a separate incision the fistula and the abscess were excised to the line of healthy tissue. Histological investigation confirmed caseous tuberculosis. After operation a plaster bandage was applied and SM+INH, later INH+PAS were administered. The patient showed remarkable improvement; in three weeks the plaster was removed, active and passive physiotherapy was initiated in bed and subaqueous exercises were soon added. After two months the patient was allowed to get up and he began to move about with crutches. By the end of five months all symptoms had vanished and the hip joint was capable of 30° painless motion. He was discharged on June 24, 1956; subsequently reported for follow-up examination every three months and



Fig 4 C
After two years the patient walked without crutches supp rt is good



Fig 4 D
Cartilage surfa e began to develop eight months f llowing operation



Fig 4 F
Radiograph taken twenty f ur months after opera ti n The tuberculous proce s has l een heal l the cartil ge is l ec ming stronger The limb is r tated f rwar l owing to u e and luxation

continued t take INH+PAS After the l p c f tw y ars he uld valk w ll without any rut he and capa it wa g d (Fig 4 C) flexi n was 40 abdu tion 0 addu t n 0 A c rding to ra li gr phic e idence th pr cess h s healed m l tely articular urface ha e d el p d but the liml ha a r tary p iti n (Fig 4 D and F In thi ca e th r ult f p r ti n i manife ted b inhibiti n of t tal arti ular l structi n an l l r st r l m tilit

DISCUSSION

Th experience and observations of several years have furnished proof that by the help of antituberculotics and appropriate surgical intervention articular tuberculosis can be healed without loss f

motility by the joint. This applies chiefly to synovial processes and to cases with slight destruction discovered at an early stage and given immediate medical care.

Since the year 1955 articular resection complemented with fibrin cap arthroplasty has been performed in 20 cases of tuberculous coxitis. A follow up period of two three years justifies the statement that operation is worth while in every case where destruction is slight and the patient's mode of life calls for restoration of articular motility. The most significant success achieved by our operations performed to obtain mobile joints has been the healing of the tuberculous process in each case. The conditions of such results are as follows.

Surgery should preferably be performed in the regressive stage attained by two three months of stabilizing treatment with drugs. If the process nevertheless shows progression, surgical intervention may be undertaken earlier in order to save the joint. However, in such cases after treatment has to be cautious, which unfortunately limits the scope of movement.

Use of the fibrin cap in arthroplasty in the presence of tuberculosis constitutes an advance. The substance is neutral to tuberculosis, does not give rise to any reaction, and the development of cartilage proceeds favourably under its protection. Radiography has shown that in three to six months the developed cartilage can be visualized by X ray.

The extent of motion depends on the condition of the muscles and the soft parts, on cicatrization which—unfortunately—is marked in recovery from tuberculosis. This consideration has induced us to avoid plaster bandages where possible, and to employ them only in the case of intense pain.

The program of after-treatment is the most essential factor of therapy and has to be adjusted individually to the patient. Establishment of a schedule prescribing both the period and measure of stabilization, exercise, bathing, moving about with crutches, and unaided walking, demands great circumspection, and has to be supported by clinical laboratory and X ray investigations. From our experiences in hip resection we have drawn the conclusion that in the case of adherence to prudent measures, regression may be expected to set in within four to six weeks.

Finally, it may be stated that, owing to modern diagnostic and therapeutic procedures, the healing of articular tuberculosis without loss of motion is possible and should be exploited to the utmost. Hip resection combined with use of the fibrin cap is also one of the methods

serving the purpose of complete restoration in some cases of tuberculous coxitis

SUMMARY

1) The authors report on ten cases of tuberculous coxitis in which mobile joints were obtained by the use of fibrin caps in hip resection

2) These patients have been followed up for a period of three years Judged by healing of tuberculosis and articular capacity results are excellent motility is satisfactory

3) In every process attended by slight destruction or upon compelling indication surgery is recommended particularly in the case of children and young women

4) The fibrin cap does not prevent regression of the tuberculous process it ensures mobility promotes the formation of cartilage and after having fulfilled its task is absorbed and vanishes without leaving behind any trace

RESUME

1) Les auteurs rendent compte de dix cas de coxite tuberculeuse dans lesquels il a ete obtenu des articulations mobiles au moyen d une capsule de fibrine dans la resection de la hanche

2) Ces malades ont ete suivis pendant une periode de trois ans Si l on se base sur la guerison de la tuberculose et la capacite articulaire les resultats sont excellents La mobilite est satisfaisante

3) Dans tous les cas chez lesquels il est question soit d une legere destruction soit d une indication peremptoire l intervention chirurgicale est recommandee en particulier chez les enfants et les jeunes femmes

4) La capsule de fibrine n empeche pas la regression du processus tuberculeux elle assure la mobilite favorise la formation de cartilage et apres avoir rempli sa mission elle est absorbee et disparait sans laisser aucune trace

ZUSAMMENFASSUNG

1) Die Verfasser berichten uber zehn Falle von tuberkuloser Coxitis in denen bewegliche Gelenke mittels der Verwendung von Fibrinkappen bei der Huftgelenksresektion erhalten wurden

2) Diese Patienten wurden wahrend einer Zeitspanne von drei Jahren beobachtet Hinsichtlich der Heilung der Tuberkulose und der Ge-

lenksfunktion waren die Ergebnisse ausgezeichnet und die Beweglichkeit war zufriedenstellend.

3) In jedem Prozess, der mit leichter Zerstörung einhergeht oder bei zwingender Indikation wird der chirurgische Eingriff anbefohlen, besonders bei Kindern oder jungen Frauen.

4) Die Fibrinkappe verhindert das Zurückgehen des tuberkulösen Prozesses nicht, sie sichert die Beweglichkeit, befördert die Knorpelbildung und wird resorbiert, nachdem sie ihre Aufgabe vollführt hat, ohne irgend eine Spur zu hinterlassen.

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FROM THE UNIVERSITY ROENTGENDIAGNOSTIC DEPARTMENT (HEAD: PROFESSOR SOLVE WELIN), MALMÖ GENERAL HOSPITAL, MALMÖ, SWEDEN

OSTEOARTHROSIS OF THE TALAR JOINTS IN FOOTBALLERS AND BALLET DANCERS

By

ÅKE BRODELIUS

Osteoarthrosis of the talar joints in footballers appears to have received little attention in the literature. *Ottani* and *Betti* (1953) found the condition to be present in all of 31 players aged 19 to 43. Os trigonum was also found to be unusually common in their series. Nothing was said about any known previous fractures, dislocations or ligament injuries.

Nor does the osteoarthrosis of the talar joints in ballet dancers seem to have received any interest.

A fairly thorough search of the literature failed to reveal any information on the age incidence of osetoarthrosis of the talar joint.

Morris (1943) and *McMurray* (1950) reported a lesion which they distinguished from osteoarthrosis and which they called "Footballer's ankle". According to them, players with this condition feel a sudden stabbing pain in front of the joint when attempting to kick the ball with the foot in full equinus. Roentgenographically it was said to be characterized by a bony ridge projecting from the anterior surface of the tibia or the talar neck at the level of attachment of the anterior capsule of the joint.

MATERIAL AND METHOD

The material consisted of 34 men, aged 21 to 46, who had been playing football regularly for more than 5 years. Seven of them had been referred for examination because of foot injury and the remainder were volunteers. Both feet were roentgen examined in all cases except 2. Notes were made of any known previous foot injury and whether the subject was right- or left-footed. None of the men had foot pain

A group of ballet dancers (13 females and 3 males) were also examined. These dancers were 18–39 years old and they had been in the profession for 3–30 years.



Fig. 1.
The talar joint of a 22 year old football player.

The control material consisted of roentgenograms of 123 men and 72 women examined for foot injury during the first 6 months of 1958. The controls were not known to be footballers or to have had any previous foot injury. Fresh ligament ruptures or fractures of the foot were diagnosed in 73. As a rule only one foot was examined.

RESULTS

The incidence of osteoarthrosis of the talar joints in the controls did not vary with sex but, as is apparent from the diagram, it increased steadily with age, namely from 3 % in patients below 24 to 50 % in those aged 45 or more. The incidence of os trigonum did not show any relation to age. It was present in 7 % of the entire group.

All of the footballers except one were found to have osteoarthrosis of the talar joints (Fig. 1). The condition was bilateral in 27 and unilateral in 6. The player without osteoarthrosis was 23 years old and all of the 6 players with unilateral changes were below 25 years (Table I). Thus even if only the less affected foot be considered the incidence of osteoarthrosis of the talar joints will still be higher than in the control series (Fig. 2).

TABLE I

	Age in years	Played (years)	Foot most used	Injury	Osteoarthrosis	Os trigonum
1 E F	46	20	R	R	R > L	–
2 T D	43	20	L	–	R > L	L
3 H A	36	17	R	Both	R∾L	–
4 I A N	34	20	R	R	R > L	R
5 A K	34	20	Both	–	R > L	–
6 B C	32	15	R	R	R∾L	–
7 A L	32	15	Both	R	R > L	
8 K S	31	15	R	R	R > L	R
9 B L	30	18	R	–	R∾L	–
10 T K	30	15	L	R	R > L	R
11 B I	29	1	L	R	R > L	–
12 K R	29	15	R	L	R < L	–
13 B D	28	12	R	Both	R > L	–
14 A S	28	15	Both	–	R∾L	–
15 L A	28	15	R	Both	R∾L	–
16 G O I	28	12	R	–	R > L	–
17 N M	27	15	Both	R	R > L	–
8 A A	27	15	Both	R	R > L	–
B L	25	10	R	L	R < L	–
H C	25				R	
L S	24				R	
A K	24	8	R	–	R	R
S A	24	8	L	R	R > L	–
L N	24	10	R		R∾L	–
C N	23	8	R	–	R∾L	–
6 A I	23	5	R	Both	R > L	–
27 L N	23	8	R		R > L	Both
8 H K	23	8	R	L	R < L	
9 O O	21	6	R	R		
30 S I	22	7	R	R	R > L	
31 B H	2	6	R	Both	L	R
32 B O	22	7	R		R∾L	
33 K F O	2	8	R		R	
34 B F	21	6	R	–	L	

Of the 34 dancers examined osteoarthrosis was roentgenologically demonstr in all except 2 aged 18 and 21 years who had been dancing for 8 years respectively (Table II) Thus as in football players osteoarthr was demonstrable in all who were above 25 years and had practi r profession for more than 8 years

Of 15 play *h previous foot injury in their history 13 were found*

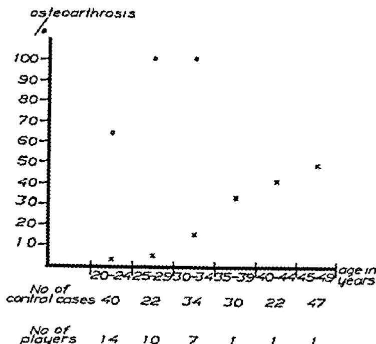


Fig 2

Incidence cf ostecarthr is of the talar j ints in f otballers ( ) and c ntrols (X) The former were cla d as ostecarthr tic nly when the change were bilateral Age group 35 49 were t small to permit percentage All had bilateral te arthr sis

TABLE II

		A n ars	Danc 3 (y ars)	I jury	O t o- arthro i
1	T I	33	30	R	R > I
2	B I	38	20	R	R > I
3	B K	33	12	L	R < I
4	C L	39	25	Both	R < L
5	S A	31	11	R	R ∾ I
6	C K	30	20	L	R ∾ I
7	H R	27	11	–	R ∾ L
8	L F	26	8		R ∾ L
9	H K	25	19	R	R ∾ I
10	R T	25	11		R ∾ I
11	P B	21	3		
12	G B	20	8		R ∾ I
13	M R	19	8	I	R ∾ I
14	N B	13	8		–
15	I L	18	14	R	R ∾ I
16	I B	18	11		R ∾ I

to have more advanced changes in that foot than in the other was preferably used for kicking by 27 players Of 11 subjects tl showed more advanced osteoarthrosis than the other Of these 11 vious injury to the foot preferred for kicking was known in /

Eight of the dancers reported that they had on some occasion tained foot injury In 3 of these the osteoarthrosis was more adv on the injuried side In the remainder no definite difference w monstrable between the severity of the changes on either side

Os trigonum was found in 17 % of the players This incidence i significantly higher than in the controls

No changes of the type said to be characteristic of Footballer s ankle (*McMurray*) were found in the present material of football players but among the ballet dancers 2 cases were found

It appears that football playing as well as ballet dancing favours the development of osteoarthrosis of the talar joints Recognized injuries can only be held responsible for a low percentage of the cases Neither can the actual kicking be blamed It would appear that the increased use of the ankles causes the osteoarthrosis but that the changes may also be caused or accelerated by trauma

SUMMARY

Osteoarthrosis of the talar joints was observed in almost all foot ballers who had regularly played the game for more than 5 years and in all ballet dancers who had been dancing for more than 8 years i e much more often than in controls

RESUME

34 joueurs de foot ball et 26 danseurs de ballet ont ete examines

L osteoarthrite des articulations du talon a ete observee chez presque tous les joueurs de foot ball qui ont joue pendant plus de 5 ans et chez tous les danseurs qui ont danse pendant plus de 8 ans c est a dire dans un nombre de cas beaucoup superieur a celui du groupe de controle

ZUSAMMENFASSUNG

34 Fussballspieler und 26 Ballettanzer wurden untersucht

Osteoarthritis der Talusgelenke wurde fast bei allen Fussballspielern die mehr als 5 Jahre regelmassig gespielt hatten und bei allen Ballettanzern die mehr als 8 Jahre getanzt hatten d h viel haufiger als in Kontrollfallen gefunden

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FROM THE ORTHOPAEDIC HOSPITAL COPENHAGEN DEPT II
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BURSITIS RETROCALCANEARIS

By

F Fuglsang and D Torup

Tender thickening at the back of the heel not infrequently leads the patient to the doctor It is those especially in the younger age group and most often *women who have this complaint The disease is generally* registered as calcaneus exostosis but ought indeed to be called bursitis retrocalcanearis since no osseous exostosis formation can ever be demonstrated only an often tender thickening of the soft tissue most pronounced just laterally of the attachment of the achilles tendon The condition is due to a state of irritation in the bursa which lies between the uppermost furthest posterior corner of the calcaneus and the achilles tendon

Various explanations have been given why this disease arises Thus *Haglund* (1928) declares that the disease occurs in those in whom the uppermost posterior corner of the calcaneus forms a particularly sharp and prominent angle This combines with a shoe whose heel piece is rigid with a sharp transverse upper edge so that an incongruency arises between shoe and heel thus the achilles tendon is pinched between the heel piece and the prominent corner of the calcaneus

Fowler and *Philip* (1945) also think that it is the shape of the calcaneus itself which determines the condition They give an account of the attachment of the achilles tendon in which one can distinguish a central part attached to the mid area of the posterior aspect of the calcaneus while the lateral parts of the tendon proceed to the medial and lateral surfaces of the calcaneus The section of the bursa which lies between the achilles tendon and the posterior aspect of the calcaneus is small while the main part of the bursa lies cranially of this surrounded by fat tissue Fowler and Philip measure the angle between the most posterior and the lowest surface of the calcaneus and in their opinion it is typical that this latter is larger than 75 degrees in these

patients The angle is measured by general X ray pictures in a lateral projection for comparison they measured the same angle in 45 normal persons and here they found the angle between 44 and 69 degrees

Ferguson and *Gingrich* (1957) quote as a method of measuring the relative prominence of the posterosuperior corner the determination of the relationship $q = \frac{a}{b}$ a is the length of a line drawn from the posterior corner of the articular surface towards the talus and the posteroinferior corner and b is the length of a line at right angles to a directed towards the posterosuperior prominent part of the calcaneus (see fig 1)

In order to evaluate the results of conservative and operative treatment we undertook a follow up investigation into a number of patients who were registered in the Orthopaedic Hospital under the diagnosis of exostosis calcanei At the same time we verified these measurements

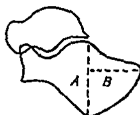


Fig 1

Determination of the relative prominence of the posterosuperior corner of the calcaneus expressed by a quotient $q = \frac{A}{B}$

THE SERIES

This comprises a follow up into patients conservatively treated in 1953 and 1954 and those surgically treated in 1953 1954 and 1955

50 patients were *conservatively* treated and 29 were contacted 18 personally and 11 in writing

In all 53 patients were *surgically* treated 32 were contacted 27 personally while 5 replied in writing

AGE AND SEX DISTRIBUTION

The average age of those conservatively treated was 17 3 while for those surgically treated it was 16 1 years (The youngest conservatively treated was 3 years old the oldest 49 years The youngest surgically treated was 11 years the oldest 35 years)

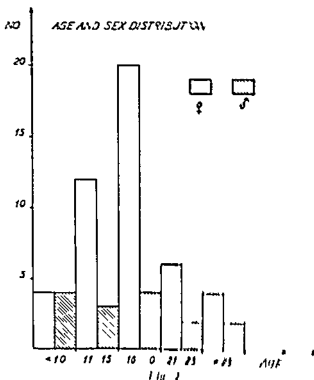


Fig [illegible]

Sex distribution

Conservatively treated	men 11	women [illegible]
Surgically treated	men [illegible]	women [illegible]

Thus the disease causes operative treatment to be given most frequently amongst women. Even if it does not clearly appear from the records according to which criteria the patients were selected for operation the impression is given however that it was especially those cases with pronounced subjective and objective symptoms which were operated on. In this connexion it may be mentioned that [illegible] of these [illegible] operated on were previously treated conservatively.

The age and sex distribution for the whole series is shown in fig 2.

TYPE OF FOOT

A slightly hollow longitudinal arch is found in the majority [illegible] have not been able to establish any [illegible] (fig. 3)

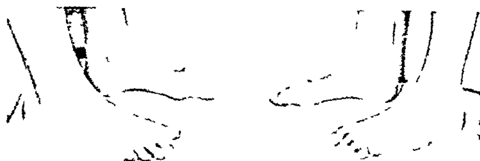


Fig. 3

This picture shows the type of foot we usually found. The hollow longitudinal arch seems typical to us.

Amongst those operated on cavus was found in 20, i.e. 63 %, 2 were classified as valgus and 8 was normal. Amongst those conservatively treated cavus was found in 15 patients, i.e. 52 %, planovalgus in 6, normal in 6. (The type of foot was not stated for 2 conservatively treated and 2 surgically treated.)

35 of the total number of patients thus had cavus feet, i.e. 57 %.

X-RAY EXAMINATION

According to *Fowler* and *Philips* principles we have measured the angle between the lowest and most posterior calcaneus surfaces by ... in 29 patients. In 4 patients (representing 6 heels) an angle grea... than 75 degrees was found, while 25 patients (representing 44 heels) ...ed a calcaneus angle less than or equal to 75 degrees.

Moreover we have measured *Ferguson's* quotient q in 31 patients representing 55 heels. 40 of these were found with $q > 0.60$ and 15 with $q < 0.60$.

The conservative treatment consisted of felt pads ... lpiece or possibly of heelless shoes.

The surgical treatment consisted of *either* simple ... prominent uppermost posterior corner of the c... section preserving the most posterior surface of ...

One patient was treated by exstirpation of ...

Results from Table 1

Conservatively treated 52 heels

	Completely recovered	improved	unchanged
	22	19	11
	(42.3 %)	(36.5 %)	(21.2 %)

Surgically treated 53 heels

	Completely recovered	improved	unchanged
Exostosis chiselling	22	12	4
Wedge resection	5	2	7
Bursa exstirpation			1
	27	14	12
	(51 %)	(26.5 %)	(22 %)

DISCUSSION

In all there were 61 patients who 3–6 years ago had visited the Orthopaedic Hospital and were registered with the diagnosis of exostosis calcanei. The patients had in common a tender thickening at the uppermost furthest posterior corner of the calcaneus, while there were no characteristic X-ray findings. At operation a bursitis was found partly below the Achilles tendon and partly subcutaneously.

In both surgical and conservative treatment the aim was to relieve the pressure on the bursa.

As a link in *the conservative treatment* it is our impression that the height of the heel has a part to play and that the so-called officer type of heel is best suited for weight relieving (the calcaneus will be less rigid and the foot will slide forward in the shoe).

The surgical methods have been discussed by various authors.

Haglund (1928) recommended simple chiselling of the most prominent part of the uppermost furthest posterior corner of the calcaneus, while *Zadek* (1939) and independently of him *Thomsen* (1941) used a wedge resection with a cranial base in order to preserve the most posterior surface intact. As a disadvantage of wedge resection it should be mentioned that the wedge must include the whole height of the bone if one wishes to avoid extra fracture lines in closing the wedge; neither *Zadek* nor *Thomsen* attempt this, but undertake only a partial resection through the vertical diameter of the bone. Impeding callus along the



Fig 4

wedge and the fracture line emerging may compromise the result and this happened in 4 cases amongst 14 heels treated with wedge resection The treatment requires furthermore 3–6 weeks plaster bandage *Zadek* has recourse to the method in 3 cases (adult patients) and is satisfied with the method although he does not however state results over a long period *Thomsen* warns against the method after employing it in one case *Breitenfelder* (1955) has used the method for children in 9 cases since he believes that chiselling is insufficient showing a tendency to recurrence No follow up investigation exists however for these 9 children *Neumeyer* (1957) doubts that this method will ensure freedom from recurrence since the apophysis is preserved and he thinks that this is what determines the prominence of the bone

In our series wedge resection was used exclusively for adults As can be seen in the tabulated results half of the 14 wedge operated heels were unchanged and impeding callus was demonstrated by X ray to be the cause of 4 of these heels

In the simple exostosis chiselling the most prominent part i e the topmost furthest posterior corner of the calcaneus was chiselled away After studying the X ray pictures taken in this follow up investigation into 33 heels it is our impression that the best results are obtained where a large smooth chiselling away is undertaken (see fig 4) 7 patients had therefore to be reoperated on owing to insufficient chiselling at the first operation

On studying the X-ray pictures considerable variation was found in the shape of the calcaneus and we did not succeed in discovering an agreement with the angle stated by *Fowler* and *Philip* and only partial agreement with *Ferguson* and *Gingrich*'s quotient. For purposes of comparison we examined X-rays of feet belonging to 10 normal people and found the same wide variation in calcaneus shape as in the series; more of these had *Fowler*'s angle or *Ferguson*'s q greater than the normal values stated by them.

Classification of the treatment results shows ¾ healed and improved in both the conservatively treated and in the operated group. As pointed out earlier *women in the 16–18 age group form the main section* while men are more evenly distributed from the age point of view.

No simple explanation of this can be given. The fact that men continue to wear the same type of footwear as used in their boyhood years while women—depending on the latest fashion—try new models, perhaps this fact plays a part. In the case of both sexes the transition from school to work takes place at the same time and brings with it greater demands of weight upon the feet.

Since the results obtained in the conservatively treated and surgically treated groups are quite uniform and the disease presumably has a tendency towards spontaneous healing (comp. its frequent occurrence in teen-agers), it seems reasonable to adopt conservative treatment at first, at least in all the less serious cases, while reserving operation for those cases in which the symptoms persist or are especially troublesome and then to adopt abundant and smooth chiselling of the furthest superior corner of the calcaneus.

SUMMARY

A follow-up investigation into 61 patients with bursitis retrocalcanearis was undertaken. The observation period was 3–5 years. The series consists of 46 women and 15 men. The average age for the conservatively treated was 17.3 years, for the surgically treated 16.1 years. 57 % of the patients had a slightly hollow longitudinal arch without demonstrable causative varus position of the heel.

¾ of both the conservatively treated and the surgically treated healed or improved.

In the case of patients, therefore, under 20 years of age with this disease our advice is always to employ conservative treatment first in the form of suitably adjusted footwear, possibly supplemented with a

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In the case of patients, therefore, under 20 years of age with this disease, our advice is always to employ conservative treatment first in the form of suitably adjusted footwear, possibly supplemented with a

felt pad in the heel piece or with a wedge under the heel. If satisfactory results are not achieved after a fairly long observation period, surgical treatment is advised with large, smooth chiselling of the furthest superior corner of the calcaneus, while wedge resection is not recommended.

RÉSUMÉ

Il a été procédé à un examen complémentaire de 61 malades souffrant de bursite rétrocalcanéenne. La période de l'observation a été de 3 à 5 ans. Parmi ce matériel d'observation, il y avait 46 femmes et 15 hommes. L'âge moyen des malades soumis au traitement conservateur a été de 17,3 ans, de ceux traités opératoirement 16,1 ans. 57 % des malades présentaient une courbure longitudinale légèrement excavée sans position varus apparente du talon.

On a trouvé parmi l'ensemble des malades, qu'ils aient été soumis au traitement conservateur ou opératoire, que ¾ d'entre eux étaient guéris ou améliorés. C'est pourquoi il est conseillé de toujours avoir recours au traitement conservateur chez les malades souffrant de cette affection qui sont âgés de moins de 20 ans, en premier lieu sous forme de chaussures appropriées, éventuellement avec une couche de feutre dans le contrefort ou un tampon en forme de coin sous le talon. Si des résultats satisfaisants ne sont pas obtenus après une période d'observation prolongée, on recommande le traitement opératoire avec une forte résection lisse de l'angle supérieur arrière du calcanéum, alors qu'une résection en coin est déconseillée.

ZUSAMMENFASSUNG

Es wurde eine Nachuntersuchung an 61 Patienten mit Bursitis retrocalcanearis vorgenommen. Die Beobachtungszeit war 3–5 Jahre. Das Material besteht aus 46 weiblichen und 15 männlichen Patienten. Das Durchschnittsalter für konservativ behandelte war 17,3 Jahre, für operativ behandelte 16,1 Jahre. 57 % der Patienten hatten eine leichte Hohlfusstype ohne nachweisbar begleitende Varusstellung der Ferse.

Sowohl die konservativ als auch die operativ behandelten Fälle waren zu ¾ geheilt oder gebessert.

Man empfiehlt daher bei Patienten mit diesem Leiden im Alter unter 20 Jahren immer zuerst eine konservative Behandlung in Form von zweckmässiger Beschuhung, eventuell ergänzt mit Filzablastung im Fersenteil des Schuhes oder einem Keil unter der Ferse, anzuwenden.

Wenn man nach lengerer Beobachtungszeit kein zufriedenstellendes Ergebnis erreicht wird die operative Behandlung mittels grosser glatter Abmeisslung der hintersten Kante des Calcaneus emphohlen Von der Keilresektion wird abgeraten

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